



Draft

**Final USS Lead Modified RCRA Facility
Investigation (MRFI) Report**

March 1, 2004

**USS Lead Refinery, Inc.
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East Chicago, Indiana**

Geochemical Solutions

Environmental Sampling, Remediation & Compliance

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EXECUTIVE SUMMARY

This *Draft Final Modified Resource Conservation and Recovery Act (RCRA) Facility Investigation (MRFI) Report* ("Draft Final MRFI Report") is prepared for USS Lead Refinery, Inc. (USS Lead), 5300 Kennedy Avenue, East Chicago, Indiana by Geochemical Solutions, L.L.C. (Geochemical Solutions). This *Draft Final MRFI Report* describes the conceptual site model, describes the work completed for site characterization at the USS Lead site and presents the data collected under the MRFI work plans. This includes the activities and data collected for on-site and off-site soil/sediment, fill, surface water and groundwater sampling at the USS Lead site to determine whether hazardous constituents from operations at the USS Lead facility pose a threat to human and ecological receptors. The *Draft Final MRFI Report* is prepared in partial fulfillment of the U. S. Environmental Protection Agency (US EPA) Administrative Order on Consent (AOC), Docket number V-W-001-94. This *Draft Final MRFI Report* presents data to fulfill requirements by US EPA in project letters (US EPA letters dated January 11, 2002, June 10, 2002, August 24, 2002, November 4, 2002, March 17, 2003 and July 2, 2003).

The overall objective of the MRFI was to determine the nature and extent of any release of hazardous constituents to off-site areas from and directly attributable to operations at the USS Lead facility. The MRFI deals with contamination migration by overland flow, i.e. surface runoff that can be directly linked to USS Lead operations, groundwater migration and air deposition.

The project objectives were:

- to gather data applicable to evaluate human and ecological exposure,
- to determine the nature and extent of contamination from activities conducted at the USS Lead site, and
- to confirm that the ISM activities conducted on and off site are protective of human health and the environment.

The MRFI site characterization began when lead contaminated soils were found present at the USS Lead site, and continued concurrent with and while driving remediation activities. The on-site sampling and analysis delineated ISM areas Area A, Area B, Area C and the canal. During site-wide sampling and analysis, additional removal areas were identified. Most soils that were identified as contaminated were removed and consolidated in the onsite CAMU. Continued sampling in the wetlands, identified elevated contaminated levels that cannot be removed from the wetlands due to physical constraints and therefore remain in place. Bioavailability testing of wetlands soil/sediment shows that less than 50% of the total lead and arsenic concentrations in the soil/sediment are bioavailable to organisms. Further, surface water and groundwater analyses show that the lead is not mobile to the groundwater or surface water. Arsenic concentrations exceed IDEM Tier 1 levels in groundwater near the former waste storage areas, but decrease rapidly with increasing distance. Arsenic remains below IDEM Tier 1 levels in all monitoring wells at the downgradient perimeter of the site.

Off-site migration of lead contaminated soils from the USS Lead site occurred with close proximity to the USS Lead site and was first identified and sampled along the perimeter railroad. Off site air dispersion was modeled by LAW and TechLaw and then substantiated using soil samples as proposed in the *MRFI Work*

Plan Addendum and as described in the *MRFI Addendum Off-Site Sampling and Analysis Report*. Sample results initiated off-site remediation as described in Appendix 3, Appendix 4 and Appendix 5. During off-site excavation debris and slag from unknown sources was encountered, and data suggested that contamination from the USS Lead site decreased with increasing distance from the USS Lead site. Further, lead slag used as fill off-site is evidenced by increasing lead concentrations with depth at several locations.

The depth of the many reports and investigations conducted for the USS Lead site suggests that the USS Lead site has been thoroughly investigated both prior to excavation, during excavation and post-excavation to confirm that removal of contaminated materials was comprehensive. This *Draft Final MRFI Report* presents data to show that both on and off the USS Lead site the nature and extent of contamination was thoroughly characterized. On and off-site soils/sediments and fill were characterized prior to waste removal, during waste removal and post-excavation. Groundwater samples have been collected quarterly since final installation of groundwater wells in the first quarter 2001. Surface water was characterized during the *Site-Wide Sampling and Analysis* and during sampling under the *Revised MRFI Work Plan Addendum*. The remaining nature and extent of contamination from activities conducted on the USS Lead site is limited to the wetlands area and is not available to humans. Moreover, the bioavailability is limited by the nature of the contaminants at the USS Lead site.

1.0 INTRODUCTION

This *Draft Final Modified Resource Conservation and Recovery Act (RCRA) Facility Investigation (MRFI) Report* ("Draft Final MRFI Report") is prepared for USS Lead Refinery, Inc. (USS Lead), 5300 Kennedy Avenue, East Chicago, Indiana by Geochemical Solutions, L.L.C. (Geochemical Solutions) to describe the conceptual site model, to describe the work completed for site characterization at the USS Lead site and to present the data collected under the MRFI work plans. This *Draft Final MRFI Report* describes the activities and data collected for on-site and off-site soil/sediment, fill, surface water and groundwater sampling at the USS Lead site to determine whether hazardous constituents from operations at the USS Lead facility pose a threat to human and ecological receptors. The *Draft Final MRFI Report* is prepared in partial fulfillment of the U. S. Environmental Protection Agency (US EPA) Administrative Order on Consent (AOC), Docket number V-W-001-94. This *Draft Final MRFI Report* presents data to fulfill requirements by US EPA in project letters (US EPA letters dated January 11, 2002, June 10, 2002, August 24, 2002, November 4, 2002, March 17, 2003 and July 2, 2003).

The components of the MRFI work plans were conducted according to the following general US EPA reference documents:

- U.S. EPA RCRA Facility Investigation Guidance, 1989, EPA 530/SW-89-031;
- *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5, US EPA, Interim Final November 1999;
- *RCRA QAPP Instructions*, US EPA, Region 5, Revision: April 1998;
- *US EPA Region 5 Ecological Data Quality Levels (EDQLs) reference database*;
- *Methods of Soil Analysis, Procedures for particle-size analysis*, 1986;
- *US EPA's Soil Screening Level User's Guide* (EPA 9355.4-23, July 1996);
- *US EPA RFI Guidance*; and
- *RCRA Ground-water Monitoring: Draft Technical Guidance*, dated November 1992.

1.1 Objectives and Scope

The overall objective of the MRFI was to determine the nature and extent of any release of hazardous constituents to off-site areas from and directly attributable to operations at the USS Lead facility. The MRFI addresses contamination migration by overland flow, i.e. surface runoff that can be directly linked to USS Lead operations, groundwater migration and air deposition.

The project objectives were:

- to gather data applicable to evaluate human and ecological exposure,
- to determine the nature and extent of contamination from activities conducted at the USS Lead site, and
- to confirm that the ISM activities conducted on and off site are protective of human health and the environment.

1.2 Purpose

The purpose of this *Draft Final MRFI Report* is to describe the conceptual site model, describe the current site conditions by summarizing past remediation and sampling efforts, and to report data collected during site sampling of soil/sediment, fill, surface water and groundwater samples. Groundwater data will be discussed in more detail in the Post Closure Permit Application to be submitted to Indiana Department of Environmental Management (IDEM). This *Draft Final MRFI Report* shows that the USS Lead site is protective of human health and the environment.

1.3 Regulatory & Reporting History

As a result of the MRFI activities, USS Lead did several cleanups and after cleanup verified that the area was clean with confirmation sampling. Summaries of all the data, both pre-excavation and post-excavation confirmatory samples are included in this report. Summaries of the investigations and submittal of data are provided below:

- *Modified RCRA Facility Investigation Work Plan, Revision 1 ("MRFI Work Plan")* (September 18, 1997). The *MRFI Work Plan*, prepared by ENTACT, initially identified the nature and extent of contamination on the USS Lead site using XRF data. The *MRFI Work Plan* reported the XRF data to USEPA and IDEM.
- *Draft MRFI Report* (December 29, 2000). The *Draft MRFI Report* outlined the contaminated areas and contained all pre-excavation and post-excavation soil data for the Railroad, Canal and Area A. As part of the *Draft MRFI Report*, an assessment of historic lead air emissions was conducted and additional groundwater monitoring wells were installed and sampled. Summaries of the data reported in the *Draft MRFI Report* are provided in this *Draft Final MRFI Report*.
- *Site-Wide Sampling and Analysis Report ("Site-Wide Report")* (July 24, 2001). The *Site-Wide Report* presented data for soil concentrations across the USS Lead site based on randomly generated soil sample locations. The *Site-Wide Report* identified additional soil which was removed (Removal Areas 1, 2, 3, 4, 5). After contaminated soils were removed, confirmatory data was reported to IDEM and US EPA in quarterly progress reports.
- *MRFI Work Plan Addendum* (April 10, 2001, approved by EPA May 30, 2001). The *MRFI Work Plan Addendum* collected surface soil and soil boring samples off-site of the USS Lead property to determine the nature and extent of off-site windborne contamination originating from the USS Lead site. The areas called the "Triangle", Howard Industries property and the property east of the site were sampled. The data were reported to US EPA and IDEM in the *USS Lead MRFI Addendum, Off-Site Sampling and Analysis Report ("Off-Site Report")* (October 15, 2001). Off-site soil was removed and placed in the CAMU according to the *Interim Stabilization Measures (ISM) Off-Site Work Plan* (September 30, 2002) and will be described in more detail in the *Final Interim Stabilization Measures (ISM) Report ("Final ISM Report")*. Data collected to confirm cleanup of off-site soil locations will be presented below as part of the current site nature and extent of contamination.
- *Revised MRFI Work Plan Addendum, Revision 2* (May 30, 2003). The *Revised MRFI Work Plan Addendum* was prepared to fulfill data gaps in determining the nature and extent of contamination at the USS Lead site. Soil/sediment, fill, groundwater and surface water samples were collected in

July 2003. Laboratory data was provided to US EPA in a transmittal dated October 30, 2003. Analysis of the data is presented below.

This *Draft Final MRFI Report* presents data to show that both on and off the USS Lead site the nature and extent of contamination was thoroughly characterized. On and off-site soils/sediments and fill were characterized prior to waste removal, during waste removal and post-excavation. Groundwater samples have been collected quarterly since final installation of groundwater wells in the first quarter 2001. Surface water was characterized during the *Site-Wide Sampling and Analysis* and during sampling under the *Revised MRFI Work Plan Addendum*.

The data derived from the documents above are all discussed and provided in this *Draft Final MRFI Report*. Data gathered for the USS Lead site were used in the development of the Site Conceptual Model. The Site Conceptual Model is described in Section 2.0 below.

2.0 CONCEPTUAL SITE MODEL

2.1 Site Location and Description

USS Lead operated a lead smelting facility on a 79-acre tract of land at 5300 Kennedy Avenue in East Chicago, Lake County, Indiana from 1920 to 1985 (Figure 1). The site is bounded to the east by Kennedy Avenue, to the north by the Indiana Harbor Belt Railroad, to the northwest by the Indiana Harbor Canal, and to the south and west by the Grand Calumet River. The USS Lead site is a combination of uplands and dune and swale topography on the eastern and northern portions of the site and low-lying wetlands to the south and south-west.

Land use in the area surrounding the subject site is primarily industrial, and the nearest residences are located approximately 0.11 mile to the north of the subject site (Figure 2).

The smelting operation covered approximately 25 acres on the eastern portion of the property and generated four primary waste materials: blast furnace slag, neutralizing sulfuric acid (calcium sulfate sludge), battery chips, and flue-dust. The USS Lead RCRA regulated units consisted of two calcium sulfate waste piles and one baghouse dust waste pile. Remediation of these materials began in 1997 after the *Interim Stabilization Measures (ISM) Work Plan* ("ISM Work Plan") was approved by US EPA. The smelting operations and waste materials are described in more detail in Sections 2.3 and 2.4 below.

2.2 Site Characteristics

2.2.1 Groundwater

The uppermost aquifer at the USS Lead site is the Calumet Aquifer (Equity Formation). The Calumet Aquifer extends from approximately the Little Calumet River to Lake Michigan. Regionally, the Calumet Aquifer is generally saturated within 10 feet of ground surface and the regional groundwater flow direction is towards the north to Lake Michigan. The site groundwater flow direction is generally to the southwest.

There are currently twenty four (24) groundwater monitoring wells on-site which are monitored quarterly according to the *Interim Status Groundwater Monitoring Plan (ISGWMP)*, dated October 16, 2000 and approved by IDEM. All groundwater monitoring well logs are provided in Attachment 1. The groundwater at the site is approximately 8.5 feet below ground surface (average first quarter 2004) and varies between 579.50 and 583.55 feet mean sea level. Groundwater flow at the site is approximately southwest, towards the Grand Calumet River, but the presence of the slurry wall around the on-site Corrective Action Management Unit (CAMU) affects groundwater flow at the site. Eighteen (18) groundwater monitoring wells on the USS Lead site are located outside of the CAMU and 6 groundwater monitoring wells are located inside of the CAMU. The groundwater potentiometric surface is illustrated in Figure 5 and the groundwater surface elevations for the first quarter 2004 are provided in Table 3.

Water is currently being pumped from inside the CAMU to establish an inward gradient across the CAMU slurry wall. Water pumped from the CAMU is sent to the East Chicago Water Treatment Plant. The maximum pumping rate was 8 gallons per minute (gpm) and the current pumping rate is averaging at approximately 4 gpm. As of December 31, 2003, approximately 2,817,000 gallons of water have been

removed from inside the CAMU. The majority of the water removed infiltrated within the slurry wall from precipitation falling on the CAMU prior to installing the cap on the CAMU.

The site hydraulic conductivity has been measured as follows:

- ENTACT, Inc. (*Report of Site Hydrogeology and Groundwater Sample Results*, December 19, 1996, Section 3.4, Page 17-18) using slug tests in wells MW-2, MW-4 and MW-5; and
- DAI Environmental (DAI) conducted pumping tests in monitoring wells MW-5, MW-13 and MW-23 on July 10-11, 2003 as part of the *Revised MRFI Addendum Work Plan* (March 30, 2003). The pumping test data is provided in Attachment 2.

ENTACT found that the mean hydraulic conductivity for the USS Lead site was 60 ft/day.

DAI conducted pumping tests to determine hydraulic conductivity in accordance with the *U.S. EPA RCRA Ground-water Monitoring: Draft Technical Guidance*, November 1992, Section 4.3.4.1, Page 4-48 through 4-50. Measured hydraulic conductivities were as follows:

- MW-5: 51.9 ft/day
- MW-13: 26.1 ft/day
- MW-23: 60.4 ft/day

Groundwater analytical data collected under IDEM illustrate that all monitoring wells at the USS Lead site have undetected concentrations of lead, illustrating that the lead at the USS Lead site is not mobile and does not infiltrate to groundwater. However, some wells have elevated concentrations of arsenic. Arsenic concentrations are highest in wells closest to the CAMU and decrease away from the CAMU. Arsenic is also present in upgradient monitoring wells and some arsenic is potentially from off-site sources.

Site-specific aquifer parameters such as hydraulic conductivity were determined for the site by ENTACT, Inc in the *Report of Site Hydrogeology and Groundwater Sample Results*, December 19, 1996, Section 3.4, Page 17-18 and DAI. The measurements collected by DAI are consistent with data collected by ENTACT for the majority of the site. However, the DAI data suggest that hydraulic conductivity decreases with increasing proximity to the Grand Calumet River. Water level elevations for the first quarter 2004 were provided in Figure 5. In addition, Figure 5 illustrates surface water elevations collected at the USS Lead site using surface water monitoring points established during the second quarter 2003.

The hydraulic gradient is variable at the site depending on location, however, the flow direction is generally to the southwest. The site gradient is affected by the presence of the slurry wall around the CAMU. A horizontal hydraulic gradient was calculated using MW-5 and MW-8 and is approximately 0.0014 ft/ft. This hydraulic gradient is consistent with data calculated by ENTACT, Inc in 1996 (*Report of Site Hydrogeology and Groundwater Sample Results*, December 19, 1996, Section 3.4, Page 18). The vertical hydraulic gradient of the site was calculated using the two site well pairs: 1) MW-4 and MW-14 and 2) MW-9 and MW-10. The results are provided in Table 1 and indicate that there is a vertical hydraulic gradient of 0.2606 ft/ft downward at the northern portion of the site, and at the south end of the CAMU, a downward gradient of 0.0075 ft/ft present. Calculations were made using the fourth quarter 2002 groundwater elevation data. Calculations made using the first quarter 2004 data are consistent with the fourth quarter 2002 data.

Table 1. Vertical Hydraulic Gradients in well pairs at the USS Lead Site.

Well Pairs	Groundwater Elevation (ft MSL)	Total Well Depth (ft MSL)	Vertical Hydraulic Gradient (ft/ft)
MW-4 (shallow)	581.59	573.60	0.2606
MW-14 (deep)	578.45	561.55	
MW-10 (shallow)	580.52	568.41	0.0075
MW-9 (deep)	580.47	561.78	

The depth of the Calumet aquifer is approximately 25 feet. At that point, Wadsworth Till is encountered which serves as an aquiclude to downward migration. The Wadsworth Till has been studied by Willman (1971), Berg, Kempton and Cartwright (1984), Hansel (1995) and Kemmis et al. (1997). Hansel (1995) described the Wadsworth Formation as “a unit containing dark gray, silty clay diamicton, overlies the Lemont Formation and is present in the moraines that encircle the southern Lake Michigan basin. The Wadsworth Formation contains less than 15% sand in its matrix; often more than 90% of the matrix is silt and clay. The Wadsworth Formation is up to 50 meters in some of the end moraines that encircle the southern margin of Lake Michigan.” Berg, Kempton and Cartwright (1984) estimated the hydraulic conductivity of the Wadsworth Till to be 1×10^{-9} to 1×10^{-7} cm/sec. Excerpts from references on the Wadsworth Till are provided in Attachment 3.

2.2.2 Surface Water

The USS Lead site is comprised of approximately 25% low-lying wetlands, adjacent to the Grand Calumet River and approximately 75% of uplands area on the western and northern portion of the site. Surface water on the USS Lead site has changed due to the ISM activities described in Section 2.8, below. Specifically, cleanup of the dust piles, battery components and contaminated soils in Areas A, B and C has taken the ground surface level below the tidal or surface water level so that surface water is now present in some portions of these areas. Two surface water samples were collected as part of the *Site-Wide Sampling and Analysis Plan (Site-Wide SAP)*, one from each Area A and Area B. In the *Site-Wide Sampling and Analysis Report (Site Wide Report)*, dated July 24, 2001, the surface water data results were as follows:

- All analyzed modified Appendix IX VOCs were undetected in all samples.
- All analyzed modified Appendix IX SVOCs were undetected in all samples.
- All analyzed modified Appendix IX metals were undetected except dissolved antimony, dissolved arsenic and dissolved barium. Dissolved antimony, dissolved arsenic and dissolved barium were detected at the following concentrations:
 - Area A: Sb – 0.045 mg/L, As – 0.0355 mg/L and Ba – 0.04 mg/L (The equipment blank had a measured barium concentration of 0.016 mg/L); and
 - Area B: Sb – 0.044 mg/L, As – 0.104 mg/L and Ba – 0.075 mg/L (The equipment blank had a measured barium concentration of 0.016 mg/L).
- All analyzed cyanide and sulfide were undetected in all samples.

Five additional surface water samples were collected as part of the *Revised MRFI Work Plan Addendum* in July 2003 to further characterize the surface water at the USS Lead site. Surface water concentrations collected in July 2003 can be summarized as follows:

- All samples had concentrations below detection limit for beryllium, chromium, cobalt, selenium, silver, tin and vanadium.
- Mercury and cadmium results had concentrations between the detection limit and the reporting limit. All concentrations were below IDEM RISC Tier 1 levels for an Industrial Site.
- Some samples had detectable concentrations of antimony, nickel and thallium and some samples were undetected. All sample concentrations for antimony, nickel and thallium were below RISC Tier 1 levels for an Industrial site.
- All samples had detectable concentrations of barium, copper, lead, and zinc, and all sample concentrations were below IDEM RISC Tier 1 levels for an Industrial site.
- Arsenic was the only constituent with surface water concentrations above IDEM RISC Tier 1 levels for an Industrial site. Concentrations of arsenic decrease with increasing distance from the center of the USS Lead site and the surface water arsenic concentration measured in the wetlands was below IDEM RISC Tier 1 levels for an Industrial site.

Surface water level staffs have been placed in Area C, the canal, Area 3, and in the Grand Calumet River and are monitored quarterly with groundwater elevations. Initial surface water level results suggest that the surface water elevations in Area C, the Canal and the wetlands are consistent with the groundwater elevations in wells in those areas, and that the surface water elevations are higher in the north (Area C) and decrease towards the south.

2.2.3 Soils

The Soil Conservation Service soil map (Lake County, Indiana Sheet Number 5) describes the general soil type to a five-foot depth. There are three soil types on the USS Lead site:

- Ur (Urban Land) for the building and hard stand locations,
- Ca (Carlisle Muck) for the southern swampy area adjacent to the Grand Calumet River; and
- OkB (Oakville-Tawas complex, 0 to 6 percent slope) for the northern and western area.

The soil interpretation record notes “the Carlisle series consists of deep, very poorly drained soils formed in woody organic deposits in bogs and other depressional areas. The surface layer is black muck 8 inches thick. The underlying material is black and dark reddish muck”. Organic matter in the soil is reported to be greater than 70%. Soil pH varies between 4.5 to 7.3. The Carlisle Muck is present in the wetlands area at the USS Lead site.

The Oakville series reportedly consists of “well drained sands formed in fine sand sediments on outwash and lake plain... The surface layer is a very dark grayish brown fine sand 7 inches thick. The subsoil is strong brown, yellowish brown, and brown fine sand 27 inches thick. The substratum is pale brown fine sand.” The amount of organic matter contained in the soil is low (0.5 to 2 percent) and soil pH is between 5.6 and 7.3. The Oakville series is present in the uplands areas. The site soils are illustrated in Figure 3.

2.3 Site History¹

The USS Lead facility was constructed in the early 1900s by Delamar Copper Refinery Company to produce copper. In 1920, the property was purchased by US Smelting, Refining, and Mining, the predecessor of USS Lead. An electric process, called the Betts process, was utilized at the facility. The Betts process produced a high-purity lead which was free of bismuth. The bismuth dross was then treated to recover gold, silver and metals of the platinum group. The site buildings constructed in the early days of operation and their uses are as follows:

- The Tankhouse, where lead refining occurred via the Betts Process;
- The Store Building, a warehouse area plus an old boiler facility;
- The Club Building, a workers cleaning area, lunchroom, locker area and cafeteria;
- The Main Office and Laboratory Building;
- An "Old Silver Refinery" building, located to the south of the western end of the Tankhouse;
- The Sulfuric Acid Building, later renamed the Battery Breaker Building;
- The Tellurium Building; and
- The Byproducts Building.

The Mixed Metals Building and Baghouse were constructed around 1926. A 50-ton blast furnace was installed to process the kettle dross but only operated on an intermittent basis due to the limited amount of kettle dross.

The facility was modified in the early 1970s to a secondary lead smelter for recovering lead from automotive batteries. Some of the kettles from the Mixed Metals Building were moved to the eastern end of the Tankhouse which became the new Alloying Department. During plant conversion, the Sulfuric Acid Building was converted for battery processing and renamed the Battery Breaker Building.

A 100-ton furnace produced 1-ton lead blocks and smaller 72-lb Pigs. The lead blocks and pigs were subsequently remelted and refined to soft lead, antimony lead and calcium lead. Metal alloys used in the refining process included silver, copper, tin, antimony and arsenic. Operations ceased at this facility in December 1985.

The location of the various facilities are pictured in Figure 6.

2.4 Waste Generation and Disposal²

The major components of the lead recovery operations were:

¹ This site history is taken from the site operations history described by ENTACT in the MRFI QAPP, revision 1, dated September 18, 1997, section 1.3.1, page 2-3.

² This Waste Generation and Disposal is taken from the waste generation and disposal history described by ENTACT in the MRFI QAPP, revision 1, dated September 18, 1997, section 1.3.2, page 3 and in the *ISM Work Plan*, Volume 1, Revision 4, dated September 17, 1996, Section 1.3.2, page 3-4.

1. battery breaking,
2. sulfuric acid collection and treatment; and
3. smelting of lead bearing components.

Smelting operations generated wastes through collection of baghouse flue dust and generation of blast furnace slag.

During battery breaking operations, the battery tops were cut off and the lead plates removed. Battery cases were disposed of in a local solid waste landfill until they became regulated as hazardous waste D008 (EP Toxicity Characteristic for lead) upon the effective date of RCRA regulations – November 8, 1980. Between September 1980 and July 1981, cut battery cases and tops were stock-piled on the southwestern portion of the site. At that time, a battery parts classifier was installed which separated the battery into plastic or rubber chips, terminal posts and lead oxide waste streams. Plastic chips were collected by plastic recovery operations and resold.

Sulfuric acid, drained from the cut battery cases, was collected in storage tanks in the Battery Breaker Building, then transferred into a large neutralization tank in the Byproducts building where lime was added for neutralization. The neutralized supernatant was discharged to the Grand Calumet River through a storm water system in accordance with the facility's National Pollutant Discharge Elimination System (NPDES) permit.

This treatment process generated a calcium sulfate sludge (D008 hazardous waste), which was dried in a Wheel-a-Brater vacuum and disposed off-site at the Chemical Waste Management landfill in Lansing, Illinois and the Gary Development Landfill in Gary, Indiana. Shortly before the cessation of secondary lead smelting operations, the vacuum drier malfunctioned and the calcium sulfate sludge was placed on a concrete foundation of the "Old Silver Refinery" Building south of the Tankhouse. This sludge was later removed, treated and disposed of at an off-site hazardous waste landfill pursuant to a Partial Interim Agreed Order with the Indiana Department of Environmental Management (IDEM).

The blast furnace baghouse collected approximately 300 tons of baghouse flue dust (listed hazardous waste K069) per month during maximum operating conditions. Some of the baghouse dust was reintroduced into the furnace for additional lead recovery; however, not all could be recycled without a significant reduction in furnace efficiency. By the late 1970's approximately 8000 tons of baghouse dust was stored on site at the Tankhouse. This baghouse dust and bags have been removed from the site pursuant to the IDEM Partial Interim Agreed Order in Cause No. N-296 and were sent for secondary lead recovery.

Slag generated from the blast furnace operations was placed in piles on the southern portion of the property (Area A). The cleanup of slag began with the approved *ISM Work Plan* prepared by ENTACT (Revision 4, September 17, 1996, Section 1, page 4) and was completed during the third quarter 2002 (Third Quarter 2002 Progress Report, prepared by USS Lead, November 15, 2002, Section 2.3.1, page 3).

The waste generation locations and onsite storage areas are illustrated in Figure 6.

2.5 Migration of Contamination

In the vicinity of the USS Lead facility, contamination has migrated by three ways: wind, surface water and anthropogenic movement as described below. The pathways for migration of contaminants at the USS Lead site are illustrated in Figure 7, Figure 8 and Figure 9 and discussed below.

2.5.1 Wind Migration

Migration of lead contamination due to air emissions and wind movement is likely based on the results of off-site sampling and air dispersion modeling. Both the modeling and soil sampling illustrate that concentrations of lead in undisturbed soils quickly decrease with increasing distance from the site. However, distinguishing between undisturbed soils and soils affected by other industrial operations in the area can be very difficult. The air dispersion modeling and off-site soil sampling results are summarized below.

To understand the USS Lead contribution of lead in surrounding soils, Law Engineering and Environmental Services (LAW) (*Draft Independent Assessment of the Impacts of Historical Lead Air Emissions in East Chicago, Indiana*, November 2000) and TechLaw (*Air Dispersion Modeling and Historic Aerial Photography Review*, April 5, 2002) modeled air emissions from the main stack and fugitive emissions from blast furnace charging operations. These air modeling reports are provided in Appendix 1 and Appendix 2, respectively. From the modeling, it was illustrated that the wind direction is mainly from the west and southwest and that USS Lead impacted off-site soils to the northeast and east. Modeling from TechLaw also showed possible impacts to the south. Modeling from LAW and TechLaw differed in the distance and maximum concentration of deposition, partly due to the fact that Law located their sources differently from TechLaw.

Off-site sampling has illustrated that wind migration of contaminants has effected lead concentration in soils for some areas close to the site. Lead concentrations in off-site soils north of the site prior to excavation are illustrated in Figure 10. During ISM excavation of the northern off-site areas in the Third Quarter 2002, it was evident that most of the triangle and areas north of the site are disturbed by past industrial activities. Undisturbed soil locations appear to be present in the western part of the "triangle" area, as indicated by relic dune and swale topography and lack of fill material. Locations on Howard Industries property (grass triangle north of the pipeline/railroad easement and south of 151st Street) had mixed concentrations, and debris and slag were found in the area, indicating disturbance by past industrial activities. For the undisturbed areas, lead concentrations decreased to below 400 mg/kg. Indicative sampling locations are OSS-50, OSS-28 and OSS-01, with lead concentrations of 269 mg/kg, 380 mg/kg and 293 mg/kg, respectively. These sample locations are located at distances of 172 feet, 217 feet and 610 feet from the USS Lead property boundary and approximately 1200 feet, 1250 feet and 1550 feet from the main stack and blast furnace operations, outside of the maximum lead concentrations from both TechLaw and LAW modeling. Therefore, the maximum impact of off-site wind migration from the USS Lead site to the north would be delineated by these sample locations.

A schematic of possible wind migration of contaminants to the east of USS Lead site is illustrated in Figure 7 and lead concentration in off-site soils east of the USS Lead site is illustrated in Figure 10. Excavation during the ISM activities indicate that no soil sample locations are undisturbed to the east of the site. However, modeling and soil sample results indicate that a combination of wind migration and anthropogenic activities contribute to soil lead concentrations east of the site. The impact of contaminant wind migration to the east appears to concentrate at physical boundaries, and the maximum concentration measured decreases at least an order of magnitude with each additional physical boundary to the east. The highest off-site soil concentrations were measured due east of the former main stack and blast furnace operations. This is illustrated in the cross section in the vicinity of the former slag pile, showing the wind migration of contaminated sediments. Anthropogenic activities are discussed in Section 2.5.4 below.

2.5.2 Surface water runoff

Contaminant lead migration by surface water runoff was likely at the USS Lead site. Surface water runoff contributed to the physical distribution of contaminants from various source areas to adjacent down-gradient areas. However, surface water and groundwater data suggest that dissolved contaminants were generally not conveyed to groundwater via surface water infiltration. Based on data collected during the second and third quarter 2002 in the wetlands (illustrated in Figure 11), and on data collected under the *Railroad Property Material Removal Work Plan*, (Adrian Brown Consultants, May 17, 1999) illustrated in Figure 10, surface water runoff contributed to contaminated soil/sediment by the following:

- surface water migration of contaminants from the former slag pile (Area A) into the wetlands (concentrations decrease with increasing distance from Area A);
- surface water runoff to the south, along the eastern side of the site and off site, along the former drainage ditch, (bounded by railroad tracks to east of site);
- surface water migration from the wetlands area to the south is limited by a berm along the Grand Calumet River; and
- surface water migration to the west and north from the former facility operations was limited by dune and swale topography but did contribute to contamination in Area B and Area C.

Pre-excavation soil sample concentrations for Area A, the wetlands and the canal are illustrated in Figure 11.

2.5.3 Surface Water Infiltration and Groundwater Migration

Contaminant lead migration by surface water infiltration to groundwater is not likely at the USS Lead site. The lead found at the USS Lead site does not dissolve or become mobile in groundwater as indicated by quarterly groundwater sampling. For example, all groundwater samples collected in the fourth quarter 2003 were undetected for lead at 0.0029 mg/L (fourth quarter data was provided to US EPA in the Fourth Quarter 2003 Progress Report). The IDEM Tier 1 default closure level for lead in groundwater for industrial sites is 0.042 mg/L. The groundwater data collected during the Revised MRFI Work Plan Addendum sampling is provided in Table 22 and groundwater data for all monitoring wells are graphed and illustrated next to the respective monitoring well on Figure 21.

Arsenic has been detected at elevated concentrations in wells near the CAMU and in wells near the upgradient property boundaries, but there is little evidence to suggest that arsenic contamination has spread down-gradient as a result of groundwater movement. Therefore, groundwater migration does not appear to represent a significant mechanism for contaminant migration. Arsenic concentration in groundwater will continue to be monitored to insure that arsenic groundwater migration is not occurring.

2.5.4 Historic Land Use Practices

Anthropogenic activities have caused contaminant migration on and off the USS Lead site. On-site, operational activities have influenced the deposition of material. For example, some lead containing material could be seen on the surface of the northeast corner of Area 2 near the railroad tracks. This material was sampled during the *Site-Wide SAP* and was removed as part of the ISM.

Based on observations during material removal excavation off-site, it is apparent that fill material has been widely utilized in the area to elevate the land surface. Significant fill material from an unknown source was deposited in the triangle area, on Howard Industries property, and along Kennedy Avenue. Buried debris, one of the evidences of fill, was found north of the USS Lead site as illustrated in Figure 16. In addition, during the *MRFI Work Plan Addendum* sampling, it was evident that original local off-site dune and swale topography had been filled in the swale locations with slag material to create a level ground surface. Railroad debris (railroad ties, switch gear, etc.) was prominent in several fill areas located adjacent to the site. Pictures of the debris encountered during excavation are provided on Figure 16. Similarly, slag had been used along Kennedy Avenue, as railroad ballast and as back fill for underground utility lines. Slag used as off-site fill may have originated from the USS Lead site or may have originated from other smelters in the vicinity such as Anaconda Lead Smelter, Eagle Pitcher Smelter or International Lead Refining Company, but would have been used or placed in these locations by the property owners. Anaconda Lead Smelter, Eagle Pitcher Smelter or International Lead Refining Company was located northwest of the USS Lead site and had been present in the area at least since 1915 as indicated in the Sanborn Library, LLC, Sanborn Map number 119, 1915, East Chicago, Indiana. A map illustrating the possible historic sources of lead in the vicinity of the USS Lead site is provided in Figure 22.

2.6 Exposure Pathways and Receptors

Historic exposure pathways and receptors are illustrated in Figure 9 and provided in Table 2 below. The USS Lead site is currently not being used for any commercial purpose and access is controlled by a perimeter fence. The CAMU portion of the site cannot be built on, but the remaining site is an industrial site and USS Lead expects that the site will remain industrial in the future. The surrounding land use is also industrial, with a residential neighborhood approximately 0.11 miles to the north.

Site contaminants have had the potential to be released by fugitive dusts, erosion, surface water runoff and uptake by plants. Contaminants at the USS Lead site were not release by volatilization or leaching mechanisms. Leaching of lead is not applicable to the USS Lead site as the form of lead present in the lead slag is insoluble at site conditions. This is evidenced by the undetected concentrations of lead in site groundwater. Further, lead does not volatilize at earth's temperatures and pressure so volatilization is not a release mechanism at the USS Lead facility.

Air, groundwater, surface water, sediments and wetlands have had the potential to be affected by soil contamination at the USS Lead site. Lead contaminated soils were exposed to all of the above media. Both surface water and wetlands are present on the USS Lead site as illustrated in Figure 8, but the site is not used for subsistence fishing, recreational fishing or any type of food production.

Possible human exposure pathways applicable to the site were inhalation of fugitive dust, ingestion of site soils or wetland sediment and/or dermal contact with site soils or wetland sediment. USS lead has been working to eliminate the soil exposure pathways through the site ISM activities. Possible aquatic exposure pathways may be ingestion of plants that had accumulated lead and ingestion of wetlands sediments. Similarly, terrestrial receptors may be exposed through ingestion of soil/sediments and ingestion of site plants. USS Lead has tested the bioavailability of lead in wetlands soils/sediments. The Midwest Hazardous Substances Research Center (Midwest HSRC) tested 4 samples collected from the wetlands

using the extraction procedure of Hettiarachchi et al. (2000)³. The results from all four samples indicated that approximately 50% of the lead in the wetlands at the USS Lead site is bioavailable. A second study was performed by Midwest HSRC to determine if the bioavailability decreased with the application of phosphate and manganese oxide, peat and iron oxide, and biosolids and iron oxide treatment to the wetlands soils/sediments. A report on the immobilization of lead and the results is provided in Attachment 4. The Midwest HSRC found that the initial lead and arsenic concentrations were 4790 mg/kg and 3760 mg/kg, respectively. Further, with no treatment, the bioavailability of lead and arsenic ranged from 800-1100 mg/kg and 100-120 mg/kg, respectively. The addition of peat and iron oxide had some reduction in bioavailability, however, none of the treatments significantly reduced the bioavailability of lead and arsenic below existing levels at the USS Lead Site.

Table 2. Identification of Exposure Pathways.

Receptors/Exposure Pathways	Contaminant Characteristics	Site Conditions
<i>Human/Direct Pathways</i>		
Ingestion (acute exposure)	Acute health effects	Possible to Site Trespassers
Inhalation (acute exposure)	Acute health effects	Historic Inhalation possible, no longer applicable
Dermal Contact	Acute health effects	Possible to Site Trespassers
<i>Human/ Indirect Pathways</i>		
Fish/meat consumption	Bioaccumulation, biomagnification	Not applicable – no site human consumption
<i>Ecological Pathways</i>		
Aquatic	Aquatic toxicity	Wetlands
Terrestrial	Toxicity to terrestrial organisms	Site vegetation

2.7 Characterization of Wastes

Characterization of the original wastes (baghouse dust, calcium sulfate sludge and blast furnace slag) was limited to 2 samples collected by Ecology & Environment in April 1981 and six samples collected by IDEM in December 1986 and the samples were analyzed for total and TCLP lead. The wastes were removed from the site before any additional characterization was completed (ENTACT, *ISM Work Plan*, Volume 1, Revision 4, September 17, 1996, Section 1.4.5, page 8). The waste manifests were provided to IDEM in the fourth quarter 2003.

Site soil, sediment, groundwater and surface water has been analyzed for Appendix IX metals, Appendix IX volatile organic carbons (VOCs), Appendix IX semi-volatile organic carbons (SVOCs), Appendix IX polychlorinated biphenyls (PCBs) and dioxins.

³ Hettiarachchi GM, Pierzynski GM, Ransom MD. 2000. In situ stabilization of soil lead using phosphorus and manganese oxide. *Environ. Sci. Technol.* 34:4614-4619.

Based on the process knowledge at USS Lead, the primary contaminant of concern is lead, which has been the primary screening constituent since the *MRFI Work Plan* (ENTACT, Inc., Revision 1, September 18, 1997, Section 2.1, page 6) was approved. During most site investigations, 20% of the samples collected for lead analysis have been analyzed in addition for the other RCRA metals. Arsenic is a possible secondary contaminant of concern due to detected site groundwater and surface water concentrations. Arsenic may be a possible secondary metal from facility operations but a definitive source has not yet been established.

Generally, wastes at the USS Lead site did not contain VOCs nor SVOCs, however, an above-ground fuel storage tank containing VOCs was present on-site for historic facility operations. The soils beneath the tank were excavated and placed in the CAMU. In addition, some on-site VOCs may have been contributed by VOCs or SVOCs coming from industries located on the Grand Calumet River via the canal. All soil samples collected during the site-wide investigation were screened using a Photoionization detector (PID) for the presence of VOCs or SVOCs. One sample had measurable concentrations of acetone and one sample had a measurable concentration of bis(2-ethylhexyl)phthalate. Both acetone and bis(2-ethylhexyl)phthalate were detected at concentrations well below the RISC Tier 1 Industrial Closure Level. VOCs and SVOCs are not primary contaminants of concern at the USS Lead site. Additional testing of VOCs and SVOCs were performed as part of the *Revised MRFI Work Plan Addendum* to verify that no cross-contamination has occurred during site activities. During the *Revised MRFI Work Plan Addendum* sampling, concentrations of VOCs and SVOCs in the canal showed that cross-contamination during site activities did not occur. However, detected VOCs and SVOCs concentrations measured in sample locations MRFI-SS-9 and MRFI-SS-11, located next to the Grand Calumet River, showed that contaminant migration of SVOCs and VOCs from the Grand Calumet River to the USS Lead site is possible.

PCB's contaminants have been detected during sampling at the USS Lead site in the canal sediments. The source of the PCBs is not known; however, PCBs are a common sediment contaminant in surface water bodies throughout the Great Lakes region. Additional PCB sampling conducted during the *Revised MRFI Work Plan Addendum* verified that PCB material removal was complete in the canal and no cross-contamination occurred during site activities. However, like detected concentrations of SVOCs and VOCs, the PCB Aroclor 1260 was detected at sample location MRFI-SS-11, located next to the Grand Calumet River, at 220 µg/kg. It is likely that VOCs, SVOCs, and PCBs are related to industrial operations in the USS Lead vicinity and migrated on the USS Lead site from industries located on and or discharging to the Grand Calumet River.

2.8 Completed Site Remediation

The USS Lead site remediation began under interim status regulations and pursuant to the IDEM Partial Interim Agreement Order in Cause Number N-296, dated April 10, 1990 and pursuant to the US EPA RCRA 3008(h) Administrative Order on Consent, Docket Number V-W-001-94, dated September 20, 1993.

Remediation of the site began during the fourth quarter 1994 and generally progressed from the whole site, the ISM and MRFI, to specific areas, such as the canal, former tank area, railroad sampling and off-site. In the third quarter 1996, five (5) groundwater monitoring wells were installed by ENTACT. The installation of the slurry wall around the CAMU was initiated on September 28, 1998 and was completed on November 12, 1998. The site-wide sampling was conducted after the majority of the ISM work was completed,

however, if an area was identified as contaminated during the site-wide SAP, material removal continued, and samples were collected to verify that the area was no longer contaminated.

After MRFI activities in June 2001 delineated off-site soil contamination which could be contributed to wind migration from the USS Lead site, USS Lead remediated off-site soils north of the site in the “triangle area” and on Howard Industries property, and east of the site along Kennedy Avenue. All excavated areas are illustrated in Figure 15 and reports detailing the off-site excavations are provided in Appendix 3, Appendix 4 and Appendix 5.

All material removed was consolidated in the CAMU according to the *Corrective Action Management Unit (CAMU) Work Plan*, dated June 10, 1998. In total, approximately 284,000 cubic yards of material has been removed and consolidated in the CAMU. The CAMU covers approximately 10 acres and is surrounded by a subsurface slurry wall. The slurry wall was installed using a vibrating beam slurry injection method using Impermix, a self-hardening, clay-cement slurry. Impermix achieves a cure hydraulic conductivity as low as 10^{-11} cm/sec. The CAMU cap was constructed in two phases to accommodate cleanup schedules and was completed in November 2002. The CAMU cap construction was inspected by DAI Environmental on a daily basis. Indigenous vegetation has been planted on the top of the CAMU to provide erosion control. The *CAMU Construction Quality Assurance Report* is being prepared by DAI Environmental and will be submitted to IDEM and USEPA.

2.9 Nature and Extent of Contamination

The purpose of the MRFI was to identify the nature and extent of contamination from the USS Lead site. Much of the data that has been collected at the USS Lead site has been to determine the nature and extent of contamination and to aid in material removal from the site and off-site.

2.9.1 Historic Nature and Extent of Contamination

Initial MRFI characterizations performed by IT Corporation and ENTACT, Inc. used XRF data to delineate the extent of contamination and found that the extent of contamination from the site was very localized to the sources and waste storage areas. This was confirmed by TechLaw modeling of three baghouse dust piles which found that the maximum impacts were within plant boundaries (Appendix 2, *Air Dispersion Modeling and Historical Aerial Photography Review*, TechLaw, Inc., April 5, 2002, Section 7.1, pg. 21).

On-site historic extent of contamination for Areas A, B and C was defined by IT Corporation in 1993 and reported by ENTACT (*ISM Work Plan*, Volume I, September 17, 1996, Revision 4, Figures 5, and 8). Additional on-site contamination was defined by the removal areas presented in the *Site-Wide Sampling and Analysis Report (Site-Wide Report)*, prepared by Geochemical Solutions, July 24, 2001, Figure 4). An illustration of historic extent of contamination is provided in Figure 12.

Material from the on-site drainage ditch extending along the southeastern boundary was removed by USS Lead where accessible. Material physically could not be removed from a portion of the drainage ditch and remains in place. The lead contamination in the drainage ditch is believed to be limited to lead in the soil/sediment. Access to this area is restricted due to a pipeline which runs very near the ground surface.

Surface soil lead concentrations off-site decrease rapidly with increasing distance from the site. Surface soil lead migrated by surface water runoff and wind migration as described in Section 2.5 above. Off-site

migration of materials was limited by the topographic highs of the railroad tracks and Kennedy Avenue. The highest off-site concentrations of lead were found next to the railroad tracks, closest to the on-site area with the highest soil lead concentrations. The higher elevation surfaces of the railroad and Kennedy Avenue were barriers or traps for lead-bearing materials during wind and surface runoff events and diminished the transport of materials away from the site. The results of the MRFI conducted by USS Lead resulted in additional material removal off-site that was contributed by wind migration from USS Lead as reported in the *USS Lead – MRFI Addendum – Off-Site Sampling and Analysis Report* provided to US EPA and IDEM on October 15, 2001.

The lead contamination at the USS Lead site has been limited to the soil/sediment. The USS Lead facility operations resulted in wastes in which the lead has not demonstrated to be mobile to groundwater based on quarterly groundwater and site-wide surface water results. The *Revised MRFI Work Plan Addendum* results for surface water and groundwater are provided in Figure 14. As stated in Section 2.2 above, surface water samples collected as part of the *Revised MRFI Work Plan Addendum* in July 2003 had all concentrations of all constituents except arsenic below IDEM RISC Tier 1 levels for an Industrial Site. Arsenic concentrations decrease with increasing distance from the center of the USS Lead site and the surface water arsenic concentration measured in the wetlands was below IDEM RISC Tier 1 levels for an Industrial site.

Groundwater sampling shows similar concentrations as those measured in the surface water. Arsenic concentrations are highest in groundwater wells close to the CAMU and the former waste storage areas, and groundwater concentrations decrease downgradient, with arsenic concentrations below RISC Tier 1 levels for an Industrial site in downgradient wells at the perimeter of the site. All lead concentrations for all wells were below RISC Tier 1 standards for groundwater. Groundwater concentrations in each well over time are illustrated for antimony, arsenic, cadmium and lead in Figure 21. Figure 21 illustrates that concentrations in groundwater at the USS Lead site have remained consistent. Antimony and arsenic concentrations in well MW-15, on the upgradient side of the USS Lead site have increased as have antimony concentrations in well MW-23. However, downgradient monitoring wells MW-6, MW-8, MW-11, MW-12 and MW-13, are consistently below RISC Tier 1 levels for all constituents of concern at the USS Lead site.

2.9.2 Current Nature and Extent of Contamination

The current nature and extent of contamination originating from the USS Lead site is believed to be contained in the onsite wetlands area. USS Lead has completed a thorough assessment of lead concentrations in the wetlands. Based on this data, USS Lead completed a 4-acre excavation in the northeastern portion (adjacent to Area A) of the wetlands to remove the area exhibiting the highest lead concentrations. Material physically could not be removed from a portion of the wetlands and remains in place. The range of measured lead concentrations in the remaining material in the wetlands ranges from below detection (<15 mg/kg) to a maximum of 20,000 mg/kg. The maximum was measured during the *Revised MRFI Work Plan Addendum* sampling at sample location MRFI-SS-7A and was sampled in close proximity to Area A. Further, MRFI-SS-7B, the sample collected from 6" to 2' below ground surface at the same location, has a lead concentration of 2,600 mg/kg, illustrating that the high concentration of lead was limited to the surface and was not mobile to the underlying soils/sediment.

The samples collected in the interior of the wetlands generally range from 1,000 mg/kg to 3,000 mg/kg. Additional samples collected from the wetlands for the *Revised MRFI Work Plan Addendum* have

soil/sediment lead concentrations of 5,200 mg/kg at MRFI-SS-8A, 1,700 mg/kg at MRFI-SS-8B, 7,700 mg/kg at MRFI-SS-9A, 1,300 mg/kg at MRFI-SS-9B, 62.0 mg/kg at MRFI-SS-10A, 84.0 mg/kg at MRFI-SS-10B, 3,200 mg/kg at MRFI-SS-11A and 200 mg/kg at MRFI-SS-11B. Soil sample lead results in the wetlands do not follow a specific trend due to the heterogeneity of soil samples, however in general, soil/sediment lead concentrations decrease rapidly with increasing distance from Area A.

As discussed in Section 2.6 above, USS Lead has tested the bioavailability of lead in wetlands soils/sediments. The first test performed by Midwest HSRC tested 4 samples collected from the wetlands using an extraction procedure and the results indicated that approximately 50% of the lead in the wetlands at the USS Lead site is bioavailable. The samples which were tested for bioavailability were only tested for lead but took into account lead speciation, alkalinity, sulfides or total organic carbon because the tests performed by the Midwest HSRC used site soils, collected from the wetlands. Therefore, the test performed by Midwest HSRC are site-specific tests and take into account all of these components to determine the lead available to the stomach and intestines of organisms. A second test was performed by the Midwest HSRC and the results are provided in Attachment 4. The second test performed by the Midwest HSRC tested to see if amendments applied to the wetlands would decrease bioavailability of lead and arsenic in the treated area. Applications of several materials did not result in significant reduction of bioavailable lead and arsenic, however, the tests also showed that when comparing the initial concentration of lead and arsenic in the wetlands soil/sediment to the bioavailable lead and arsenic when zero amendment was applied, the amount of bioavailable lead and arsenic in test two ranged from 800 to 1100 mg/kg lead and 90 to 120 mg/kg arsenic. Initial average lead and arsenic concentrations of the second test performed by Midwest HSRC were measured at 4790 mg/kg and 3760 mg/kg respectively. Based on the limited bioavailability of lead and arsenic, and because a large part of the impacted area was excavated, USS Lead believes the remaining lead concentrations in the wetlands do not pose a significant exposure risk.

Site-specific chemical data on soil pH, cation exchange capacity (CEC) and total organic carbon (TOC) was measured during the *Revised MRFI Work Plan Addendum*. Soil pH values ranges from 4.9 for one sample collected in the wetlands (MRFI-SS-8A) to 8.0. The majority of the samples were measured with pH ranging from 6.0 to 7.2. CEC was generally measured less than 15 meq/100g. Two samples, MRFI-SS-8A and MRFI-SS-23 had CEC above detection and were measured at 17 and 15 meq/100g, respectively. TOC measurements ranged from 730 mg/kg to 190,000 mg/kg in the wetlands.

The nature and extent of contamination in Area 2 was first delineated by IT Corporation in 1993, using a portable XRF to measure surface lead concentrations. In September 2000, under IDEM, USS Lead conducted random sampling on a grid as part of the site-wide sampling activities, and a pile of baghouse dust was found in Area 2 (*Site-Wide Report*, Section 3.4.2, Page 8-9). The pile of baghouse dust found in Area 2 was believed to be an isolated pile, stored in the area for facility operational convenience because the sample SS-04-01 was the only sample in Area 2 with elevated soil lead concentrations. The surface soil sample SS-04-011 had a lead concentration of 1,370 mg/kg, while the sample SS-04-012, taken at 1' bgs had a soil lead concentration undetected at 5.1 mg/kg. Further, other surface soil samples collected during the site-wide sampling and analysis activities in Area 2 had soil lead concentrations of 438 mg/kg (SS-02-03), 42 mg/kg (SS-02-04), 365 mg/kg (SS-02-05), 168 mg/kg (SS-02-06), 712 mg/kg (SS-04-04, surface sample), 762 mg/kg (SS-04-05, surface sample), 148 mg/kg (SS-04-031), 5.2 mg/kg (SS-06-02) and undetected at 5.0 mg/kg (SS-06-03). Therefore, the baghouse dust pile in Area 2 was limited to the surface soil and was the only sample which revealed such contamination in that area. Confirmatory samples around the removal area were collected (SS-21-04 and SS-21-06 with soil lead concentrations of 1.9 mg/kg and

1.8 mg/kg, respectively) and confirmed that the material had been removed. Area 2 was sampled by TechLaw in August 2002 and additional investigation of Area 2 was conducted in the *Revised MRFI Work Plan Addendum*. USS Lead collected twelve additional samples from eleven locations to investigate the current nature and extent of contamination and to fulfill data gaps in Area 2 according to the *Revised MRFI Work Plan Addendum*. The sample locations and analytical results are provided in Table 17 and illustrated in Figure 13. All lead concentrations for all samples collected for the *Revised MRFI Work Plan Addendum* in Area 2 were below RISC Tier 1 levels for an Industrial site. From all of the data collected and described above for Area 2, no soil contamination from USS Lead activities is present in Area 2 and the historic nature and extent of contamination in Area 2 was limited to the one baghouse dust pile which was identified and removed.

In US EPA's June 10, 2002 comments on the *MRFI Work Plan Addendum* (General Comment Number 4 and General Comment Number 5) and in US EPA's August 29, 2002 comments (General Comment Number 6), US EPA states that "additional off-site sampling to the north of the site to determine the nature and extent of lead contamination from the facility in the residential areas north of the site..." is necessary, however, USS Lead believes that in light of the new data collected in the third quarter 2002 (described in Section 2.5.1 and illustrated in Figure 10 and Figure 12) and in light of the TechLaw modeling results which indicate that the maximum impact would be 300 meters from the source (within the triangle area to the north), USS Lead impact to the north in the residential area is limited to below US EPA residential preliminary remediation goals (PRGs) of 400 mg/kg. The third quarter 2002 triangle data, illustrated in Figure 10, indicate that there are at least four soil sampling locations in the triangle which are below residential PRGs. Further, the western area of the triangle appeared to be less disturbed and therefore more representative of air emissions, wind deposition and lead contaminant migration from the USS Lead site as opposed to anthropogenic influence observed to the north and east. In this area, concentrations decrease with increasing distance from the site (also noted in the USS Lead *MRFI Addendum Off-Site Sampling and Analysis Report*, dated October 15, 2001, Section 3.3, Page 6, first bullet and Section 5.0, Page 11, first bullet), and depth data showed that lead contamination is limited to the surface, indicating that lead-containing material was not dumped in the area. In addition, other possible sources of historic lead, such as the Anaconda Lead Products facility and the International Lead Refining Company (Figure 22) in the immediate vicinity north of the USS Lead site could contribute to soil lead concentrations north of E 151st Street. Therefore, data sampling in the residential neighborhood to the north of the site is not proposed; however US EPA is still reviewing the data from the off-site area and has collected samples in the area. An approximate pre-excavation soil isoconcentration map is provided in Figure 12.

During the third quarter 2002, USS Lead remediated the surface soil in the "triangle" area north of the site, on Howard Industries property and along the Indiana Harbor Belt Railroad to the east of the site. During material removal, several areas with contaminated debris not originating from the USS Lead site were located and left in place. These areas are illustrated in Figure 16. Off site excavation reports are provided in Appendix 3, Appendix 4 and Appendix 5.

The lead contamination at the USS Lead site has been limited to the soil/sediment. The USS Lead facility operations resulted in wastes in which the lead has not demonstrated to be mobile based on quarterly groundwater and site-wide surface water results.

Recent sampling has indicated that arsenic is present in the groundwater at a maximum concentration of 2.0 mg/L during the fourth quarter 2003 and near the CAMU in well MW-18. However, arsenic concentrations are below detection limits in the groundwater monitoring wells along the southern and

western boundary of the site. It appears that some arsenic may be migrating onto the USS Lead site as upgradient groundwater monitoring wells also have detected concentrations of arsenic.

Surface soil samples were sent to NET Laboratories (Test America), of Bartlett, Illinois for total lead analysis and potential analysis for RCRA metals and Target Analyte Metals.

3.4 Area B and Area C Sampling, Excavation and Confirmatory Sampling

3.4.1 Area B

The battery chips were located in Remediation Area B as illustrated in Figure 6. Area B was sampled by IT Corporation and the field XRF data are illustrated in Figure 6. The battery chips and Area B material was excavated by ENTACT, as contracted by USS Lead, during the second quarter 1997. The confirmatory soil samples collected during the second quarter 1997 from Area B met the 5,000 mg/kg lead action level of the ISM Work Plan (data was submitted with the Second Quarter 1997 Progress Report). However, the area incorporated in Remediation Area B continued to grow, and further excavation and sampling was conducted for Area B during the third quarter 1997 and the fourth quarter 1997. All verification data was submitted with the respective quarterly progress report to US EPA and IDEM. Soil sampling results from the fourth quarter 1997 illustrated that excavation in Area B was complete in accordance with the Consent Order and the ISM Work Plan.

Additional work was performed by USS Lead to remove material in Area B to below the IDEM Tier 1 RISC closure levels for an Industrial site (1,300 mg/kg lead), and in many locations below the US EPA Region 9 PRGs for residential soils (400 mg/kg for lead), exceeding the requirements of the Consent Order and the ISM Work Plan. Additional confirmatory samples were collected under the Site-Wide Sampling and Analysis Plan (Site-Wide SAP) to illustrate that Area B met the IDEM default closure level. This data was submitted to IDEM and USEPA in the Site-Wide Sampling and Analysis Report (Site-Wide Report) by Geochemical Solutions, and dated July 24, 2001. Additional confirmatory samples of both the surface water and the soil in Area B were collected for the *Revised MRFI Work Plan Addendum* in July 2003. The *Revised MRFI Work Plan Addendum* soil/sediment sample results are provided in Table 17 and illustrated in Figure 13. Surface water results are provided in Table 23 and illustrated in Figure 14. Area B current site sample concentrations collected under several sampling programs are illustrated in Figure 20.

3.4.2 Area C

Remediation Area C was located north of the CAMU. These soils were sampled by IT as illustrated in Figure 6. These soils were excavated by ENTACT during the third quarter 1997 and verification sampling was performed. The soil data from verification sampling was provided to USEPA and IDEM in the Third Quarter 1997 Progress Report and illustrates that the Area C soil was removed to concentrations below Region 9 PRGs for residential soils (400 mg/kg for lead), exceeding the requirements of the Consent Order and the ISM Work Plan, except for at one sampling location. Additional remediation of that sampling location was conducted during the fourth quarter 1997, and verification samples were collected to verify that lead concentrations were below the cleanup standard. In fact, the lead concentrations of the verifications samples were below RISC Tier 1 Residential levels and were measured 18 mg/kg total lead and undetected at 2.8 mg/kg total lead (Fourth Quarter 1997 Progress Report). Confirmatory samples for Area C are illustrated in Figure 20.

3.0 FIELD ACTIVITIES AND ANALYTICAL RESULTS

Remediation work at the USS Lead was completed over eight years, through several work plans and using several contractors. As a result, numerous site sampling events were conducted to verify the nature and extent of contamination at the USS Lead site and confirm that ISM cleanup had been completed.

For each sampling event, sample equipment was gathered, equipment was calibrated, decontaminated and procedures were used to prevent contamination of the samples during the sampling activities. Sample locations were chosen to determine the nature and extent of contamination at the USS Lead site and to insure that cross-contamination during ISM activities did not occur.

The following tasks have been completed as part of the MRFI and ISM activities:

- Surface Soil Sampling – Initial XRF Screening completed by IT Corporation, additional sampling completed by ENTACT (Section 3.1)
- Subsurface Soil Sampling – completed by ENTACT (Section 3.2)
- Drainage Ditch Characterization – completed by ENTACT (Section 3.3)
- Area B and Area C Sampling, Excavation and Confirmatory Sampling – Completed by ENTACT, USS Lead and LAW, with additional confirmatory sampling by Geochemical Solutions (Section 3.4)
- Area A Sampling, Excavation and Confirmatory Sampling – completed by ENTACT, USS Lead and Adrian Brown Consultants (Section 3.5)
- Railroad (Perimeter) Soil Sampling, Excavation and Confirmatory Sampling – completed by ENTACT, Adrian Brown Consultants, USS Lead and LAW (Section 3.6)
- Canal Sampling, Excavation and Confirmatory Sampling – completed by ENTACT, USS Lead and LAW (Section 3.7)
- Site Wide Sampling, Excavation, Confirmatory Sampling – sampling completed by LAW, report submitted by Geochemical Solutions (Section 3.8)
- Monitoring Well Installation and Groundwater Sampling – installation completed by LAW, quarterly groundwater sampling completed by DAI Environmental (Section 3.9)
- Canal Access Road and Holding Ponds – completed by DAI Environmental and USS Lead (Section 3.10)
- Grand Calumet River Sediment Characterization – completed by IDEM (Section 3.11)
- Lead Area of Influence Study – completed by LAW (Section 3.12)
- Historical Lead Air Emissions Report – completed by LAW, A review by TechLaw and an addendum by TechLaw (Section 3.13)
- MRFI Addendum – Off-Site Sampling, Excavation and Confirmatory Sampling– Completed by Geochemical Solutions, USS Lead and DAI Environmental (Section 3.14)

- Wetlands Sampling, Excavation and Confirmatory Sampling – Completed by DAI Environmental and USS Lead (Section 3.15)
- Revised MRFI Work Plan Addendum Sampling – Completed by Geochemical Solutions and DAI Environmental (Section 3.16)

A brief summary of each investigation is provided below. Data for the sampling events are provided in the referenced tables.

3.1 Surface Soil Sampling

In order to determine the nature and extent of contamination at the USS Lead Site, IT Corporation collected approximately 475 XRF samples of surface lead in 1993 at the USS Lead site. These sample results were first reported in the ISM Work Plan, Dated September 17, 1996 and have been used at the USS Lead site to determine excavation areas. The IT data are illustrated with the former waste storage areas on Figure 6.

In January 1998, ENTACT collected surface soil samples at designated locations in general accordance with the MRFI Workplan, Revision 1. The surface soil sampling was implemented by setting up a grid-like orientation where soil sampling was conducted on 100-foot centers paralleled to the property boundary. The MRFI Workplan called for samples to be analyzed for lead with a field portable XRF to determine if lead concentrations exceeded 400 mg/kg. Due to soil moisture problems, the XRF was not utilized and soil samples were collected for laboratory analysis of total lead. Surface soil samples were sent to NET Laboratories (Test America), of Bartlett, Illinois for total lead analysis and potential analysis for RCRA metals and Target Analyte Metals.

Select samples were analyzed for RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver). Verification samples were analyzed for additional metals by comparison to Ecological Data Quality Levels.

3.2 Subsurface Soil Sampling

ENTACT personnel collected six subsurface soil samples from three soil borings at locations N-5, E-4 and E-7 on January 15, 1998 to determine the vertical extent of soil contamination. Subsurface samples were collected at designated location in accordance with the *MRFI Workplan*, Revision 1. Subsurface soil samples were collected within one lateral foot of the surface soil samples exhibiting the highest total lead value.

Subsurface samples were collected using a hand auger. Subsurface soil samples were analyzed for total lead. The results of the vertical profile indicated that elevated lead concentrations at the surface decrease rapidly with depth. Lead concentrations at all three borings were reported at or near background concentrations at a depth of 2 feet below the surface. Impacted lead soil prior to excavation appeared to be primarily concentrated in the upper one-foot of the soil column.

3.3 Drainage Ditch Characterization

Soil samples were collected in the drainage ditch outside the fence on the southeastern border of the site to characterize the off-site impacts to the wetlands adjacent to the USS Lead facility. ENTACT collected eight surface soil samples on January 15, 1998 along the southeastern border of the USS Lead site in accordance with the *MRFI Workplan*, Revision 1. Sample transect locations were called E-1, E-2 and E-3.

3.5 Area A Sampling, Excavation and Confirmatory Sampling

The lead slag pile was located at the southern end of the CAMU as illustrated in Figure 6. The lead slag pile was initially removed by ENTACT according to the *ISM Work Plan*. The lead slag pile was removed by the following process:

- During the third quarter 1996, ENTACT constructed a segregation berm between the wetlands and the slag pile to contain lead-contaminated material during removal activities. The segregation berm was made of clay and was tested as described in the third quarter 1996 progress report.
- Excavation of the lead slag pile began during the first quarter 1997 when ENTACT excavated and consolidated in the CAMU 3,242 loads of lead slag material as reported in the First Quarter 1997 Progress Report. Verification sampling also began at this time and was submitted with the First Quarter 1997 Progress Report, Second Quarter 1997 Progress Report, Third Quarter 1997 Progress Report.
- A clay levee was installed along the south end of the CAMU to stabilize the CAMU boundaries on the south and west sides, near Area A and the canal as described in the Second Quarter 1997 Progress Report.
- In accordance with the *Area A Remediation Work Plan*, dated January 17, 2000, USS Lead continued to remove material from this area to soil below a lead concentration of 1,300 mg/kg and exceeded the requirements of the *ISM Work Plan*. To do this, USS Lead contracted Adrian Brown Consultants of Denver, Colorado to sample the remaining soil in the area (now called "Area A") and to determine a depth of removal. Area A was sampled in January 2000 and the data collected by ABC is provided in Table 4 and illustrated in Figure 18. USS Lead then proceeded to excavate the lead slag area as approved by US EPA and IDEM.

The confirmatory samples represent an average lead concentration of 56.7 mg/kg (Table 4), far exceeding the requirements of 5,000 mg/kg lead established in the *ISM Work Plan*, and further, well below Region 9 Preliminary Remediation Goals (PRGs) for residential soils of 400 mg/kg.

3.6 Railroad (Perimeter) Sampling, Excavation and Confirmatory Sampling

Ninety-two (92) surface samples were collected at 6" bgs and seven samples were collected from 3 soil borings at depths of 12", 18" and 24" bgs along the railroad to the north and east of the site by ENTACT in December 1997 in accordance with the *MRFI Work Plan, Revision 1*, dated September 18, 1997 to determine the nature and extent of contamination from the USS Lead site. Sample locations and results are illustrated on Figure 10. The results from the pre-excavation sampling suggest that lead contaminated soil migrated along the ground surface either by wind or surface water migration and was stopped by the topographic high of the railroad tracks. This is illustrated in the cross section schematic presented in Figure 7. Further, the highest lead concentrations along the railroad tracks were measured closest to the former sources of lead. For example, the highest railroad concentration was measured closest to the former slag pile (Area A).

USS Lead removed an estimated volume of 5,100 cubic yards of lead-impacted soil from the railroad line located along the north and east sides of the subject property. As stated in the *Railroad Property Material Removal Work Plan*, dated May 17, 1999, confirmatory soil sampling of the excavated area is required as part of the MRFI. LAW personnel collected twenty-two (22) soil samples in general accordance with the

Railroad Property Material Removal Work Plan. Two confirmatory samples CRR 9 and CRR 10 returned levels of 2,330 mg/kg lead and 2,560 mg/kg lead, respectively. Sample locations are illustrated in Figure 18 and results are provided in Table 5 and Table 6. These two areas were located within close proximity to railroad infrastructure and were unable to be excavated with mechanized equipment. After receiving results of the two above samples, USS Lead cleaned this area manually and placed the material into the CAMU. Following confirmatory sampling, the majority of the railroad area was backfilled with clean sand. The area excavated by USS Lead along the railroad tracks is illustrated in Figure 15.

On September 12, 2000, LAW and USS Lead conducted confirmatory soil sampling along the railroad line to the north and east of the USS Lead site. Twenty sample locations were marked with stakes at approximately 200-foot intervals, starting at CRR-11 and working west and south from that point. Points CRR1 and CRR2 were not able to be located because of lack of space on the south end of the sample area. Confirmatory railroad sampling data are provided in Table 5 and Table 6 and sample locations are illustrated in Figure 18. Once the sampling locations were determined, four additional points at each location were marked approximately one foot from the sample location, equally spaced around the sample location.

The following activities were initiated as part of the confirmatory railroad soil sampling:

- Sample locations were marked with wooden stakes.
- Soil samples were collected at approximately 6 inches below ground surface.
- All soil samples were analyzed for total lead.
- Ten percent of the soil samples were analyzed for the RCRA Metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver), and antimony, copper, nickel, vanadium, and zinc.
- Trip blanks were prepared by the analytical laboratories and carried through sampling activities.
- Rinsate blanks were prepared for the field sampling equipment to confirm adequate decontamination practices.

A plastic sheet was placed on the ground over the sample area and holes were cut to gain access to the sample points under the sheet. One scoop of soil each was dug at a depth of approximately 6 inches below ground surface (bgs) from the sample location and the four points surrounding the sample location utilizing a decontaminated plastic scoop and placed into a decontaminated plastic mixing bowl. The soil was then homogenized utilizing the plastic scoop and a sufficient amount of soil was placed into appropriate laboratory containers for total lead (EPA Method 6010B), RCRA metals, antimony, copper, nickel, vanadium, and zinc analysis. RCRA metals were analyzed by EPA Methods 6010B, 7060, 7471A, 7740, and 7760.

Upon completion of soil sample collection, samples were sent to Test America, Inc., in Bartlett, Illinois, an approved EPA laboratory, via FedEx under a chain-of-custody for laboratory analyses.

3.7 Canal Sampling, Excavation and Confirmatory Sampling

The *ISM Work Plan* set forth a sampling strategy to characterize the extent and level of contamination in the sediment of the outfall canal leading to the Grand Calumet River. The canal was characterized in September 1997 by ENTACT and then Adrian Brown Consultants re-sampled and characterized the canal

with extensive sampling in March 2000 (Figure 11). The canal was remediated according to the *ISM Work Plan* and the *Canal Remediation Work Plan*, dated May 31, 2000 and written by Adrian Brown Consultants. Impacted material from the base of the canal was stabilized and placed in the CAMU. Confirmatory samples were collected in September and October 2000. A *Report of Canal Sampling and Analytical Results – Post Remediation* was submitted to the IDEM and EPA on December 8, 2000. IDEM approved remediation of the canal in a letter dated March 8, 2001 and in an e-mail correspondence on August 22, 2001.

Approximately 20,114 yds³ of material was excavated from the canal. The excavated material was placed in the on site CAMU and the excavations were backfilled with clean sand mined from northern portion of the property. The confirmatory soil sample data is provided in Table 7 and illustrated in Figure 18.

3.8 Site-Wide Sampling, Excavation and Confirmatory Sampling

Soils containing elevated concentrations of lead have been remediated at the USS Lead Site pursuant to the approved *ISM Work Plan* and in partial fulfillment of the Partial Interim Agreed Order in Cause No. N-296 (effective April 13, 1990). The *Site-Wide Sampling and Analysis Report* ("*Site-Wide Report*") provided data collected on the soil, sediment and surface water at the USS Lead Site to verify that the site meets remediation goals in partial fulfillment of the Indiana Department of Environmental Management (IDEM) requirements for closure and the Partial Interim Agreed Order in Cause No. N-296. The data collected for the *Site-Wide Report* was also submitted to US EPA in partial fulfillment of the ISM and the MRFI.

Soil, sediment and surface water at the USS Lead site was sampled according to the approved *Site-Wide Sampling and Analysis Plan* ("*Site-Wide SAP*"), dated April 24, 2000 and approved by IDEM on August 9, 2000 with modifications agreed to on August 22, 2000 in a letter from Adrian Brown Consultants to IDEM. Soil, sediment and surface water sampling activities were performed in accordance with the approved *Site-Wide SAP* and the RISC User's Guide. Material in areas which did not meet site closure requirements and which could be removed was consolidated into the CAMU during the winter and spring 2001 and confirmatory samples of the areas were collected in spring 2001.

The *Site-Wide SAP* determined the nature and extent of on-site areas at the USS Lead site that require further remediation. The following conclusions were based on the results of the *Site-Wide SAP*:

- All VOCs and SVOCs were below RISC Tier 1 Industrial Closure Levels.
- Five (5) removal areas were defined during the Site-Wide investigation.
- Three removal areas were cleaned as part of the material removal associated with the Site-Wide investigation. Removal Area 1 was cleaned and the confirmatory samples, collected on July 19, 2001, confirmed that soil concentrations in Removal Area 1 were below RISC Tier 1 Industrial Closure Levels. Removal Area 2 was cleaned and confirmatory samples collected on April 5, 2001 measured soil concentrations below RISC Tier 1 Industrial Closure Levels for lead, antimony, arsenic and cadmium. Confirmatory sample soil concentrations at Removal Area 3 indicated that 98.4% arsenic removal was achieved. Arsenic is not mobile at the USS Lead site, and no further material removal of this area was performed.
- Remediation of Removal Areas 4 and 5 (Wetlands area)(site-wide sample locations SS-01-04 and SS-04-02) was performed as described in section 3.15 below.

Soil, sediment and surface water was sampled according to the *Site-Wide SAP* by LAW on September 13 – October 6, 2000. Soil, sediment and surface water analyses were conducted by Test America, Inc. in Bartlett, Illinois, an approved EPA laboratory as per the approved *Site-Wide SAP*. Material in areas which did not meet site closure requirements and which could be removed was consolidated into the CAMU during the winter and spring 2001 and confirmatory samples were collected on April 5, 2001. The confirmatory samples were analyzed by Severn Trent Laboratories in Chicago, Illinois. Severn Trent Laboratories is an approved EPA laboratory and has provided a Quality Assurance Project Plan to US EPA to meet the project objectives.

An additional sample was collected on April 20, 2001 when US EPA's contractor Techlaw identified an area that appeared to be slag material. This sample was also included with the confirmatory sample locations and results.

3.8.1 Soil Sampling

The surface soil sampling was implemented by setting up a sampling grid oriented north-south and east-west, using 100-foot spacing as described in the *Site-Wide SAP* and in accordance with the RISC User's Guide (Section 2.4). A random sample generator was used and the cube root of the total number of grid intersection points was used to determine the number of sample locations.

Twenty-six (26) surface soil sample locations were identified and samples were collected. In addition, 7 soil borings were drilled and 44 samples were collected from those borings. Subsurface samples were collected from 1 foot, 2 feet, 3 feet, 4 feet and 5 feet below ground surface (bgs) as described in the *Site-Wide SAP*. Site-Wide soil sample locations are indicated by a "SS-1" through "SS-6" and are illustrated in Figure 11 (for areas with additional remediation), Figure 18 (for samples where the area was backfilled) and Figure 20 (current site – site-wide samples where no further action was taken).

In addition to the surface and sub-surface sampling, 4 soil boring locations were sampled as recommended in the RISC User's Guide (Section 2.4.2). The additional 4 soil borings were drilled north of the CAMU where potential background concentrations could be determined. A total of 24 samples were collected from the 4 soil boring locations.

A total of 84 soil samples were collected at the USS Lead site as part of the *Site-Wide SAP*.

3.8.2 Confirmatory Soil Samples

Confirmatory soil sampling events were performed on April 5, 2001, April 20, 2001 and July 19, 2001 after contaminated material had been removed and consolidated in the CAMU. The confirmatory soil samples were collected in accordance with the *Site-Wide SAP* with the exception that Severn Trent Laboratories in Chicago, Illinois, an approved EPA laboratory, analyzed the samples. The April 20, 2001 confirmatory sample (SS-23-01) was collected when US EPA's contractor, Techlaw, identified an area that appeared to be slag material. This sample is also included with the confirmatory sample locations and results. A total of nine confirmatory samples were collected at the USS Lead site on April 5, 2001 and April 20, 2001. These samples are indicated by "SS-20" through "SS-30".

3.8.3 Surface Water Samples

Two surface water samples were collected as part of the *Site-Wide SAP*. Surface water results were presented to US EPA and IDEM in a letter from Geochemical Solutions on March 30, 2001. The sampling was performed in general accordance with the approved *Site-Wide SAP*. A summary of the surface water results is provided below:

- All analyzed modified Appendix IX VOCs were undetected in all samples.
- All analyzed modified Appendix IX SVOCs were undetected in all samples.
- All analyzed modified Appendix IX metals were undetected except dissolved antimony, dissolved arsenic and dissolved barium. Dissolved antimony and dissolved arsenic were detected at concentrations below IDEM criteria for Human Health, Noncancer, non-drinking water sources. IDEM has not established criteria for dissolved barium concentrations in surface water.
- All analyzed cyanide and sulfide were undetected in all samples.

3.9 Monitoring Well Installation and Groundwater Sampling

ENTACT installed five wells (MW-1 through MW-5) in soil borings (BH-1 through BH-5, respectively) in August 1996 in partial fulfillment of the Closure Plan submitted to IDEM. Monitoring wells were developed, sampled and slug tests were performed as described in the *Report of Site Hydrogeology and Groundwater Analytical Results*, dated December 19, 1996. Monitoring wells were installed at the USS Lead facility in order to assess the hydrogeologic conditions. Water level measurements indicated that the direction of groundwater flow is to the southwest toward the Grand Calumet River as illustrated in Figure 5.

To further assess the groundwater at the site, LAW personnel observed the installation of nine (9) monitoring wells (MW-6, MW-7, MW-8, MW-9, MW-10, MW-11, MW-12, MW-13, MW-14) on the USS Lead site. Monitoring wells were installed in general accordance with the *Interim Status Groundwater Monitoring Plan*, dated May 9, 2000, prepared by Adrian Brown. The monitoring wells were installed to determine if the facility has impacted the groundwater quality of the shallow aquifer. Monitoring wells were installed by Fox Drilling Company of Itasca, Illinois. Seven of the monitoring wells were installed to depths ranging from approximately 14 feet to 18 feet below ground surface (bgs) and two wells (MW-9 and MW-14) were installed at depths of approximately 28 to 30 feet bgs utilizing a truck-mounted drill rig with 4 1/4-inch inner diameter continuous-flight hollow stem augers. Samples were collected at two-foot intervals utilizing a two-foot long sample barrel. The soil was classified by LAW personnel, and placed in jars covered with aluminum foil. The headspace of the jar was field screened with a calibrated Photoionization Detector (PID).

The monitoring wells were constructed of 2-inch inside diameter 10 foot long 0.010 inch slotted PVC well screens and extended to above ground surface with Schedule 40 PVC riser pipes. A sand pack of #3 (10-20) washed silica sand was installed to two feet above the top of the well screen. A two-foot bentonite seal was placed on top of the sand pack. The remainder of the borehole was filled with cement grout to ground surface. The monitoring wells were completed at ground surface with stick-up style locking well covers that are anchored with a concrete pad at the base so that water will drain away from the well stems.

Eleven additional monitoring wells (MW-15 through MW-25) were installed by LAW around the CAMU in February 2001, developed and sampled as part of the quarterly groundwater samples described below. Groundwater wells inside the CAMU are not included in quarterly groundwater sampling, but are used to determine water levels within and water gradients across the CAMU slurry wall. Wells completed inside the CAMU are constructed using 4 inch diameter stainless steel well casing and screen and provide locations to pump and dispose of water that is contained within the CAMU.

Upon completion of monitoring well installation, monitoring wells were developed to remove sediments. Wells were developed using surge and bail techniques. Prior to well development, the depth to water and total depth of each well was measured. Well development was conducted utilizing a dedicated, weighted single check valve disposable bailer at each well location. Development consisted of extracting water from each well until it was reasonably free of sediment and measurements of pH, temperature, turbidity, and specific conductivity stabilized or until the well bailed dry. If the sediment in the groundwater did not significantly decrease during well development, a maximum of 10 well volumes of water was removed from the well. Purge water was transported to and disposed of on the CAMU.

Monitoring well logs are provided in Attachment 1 and monitoring well locations are illustrated in Figure 5. Quarterly groundwater sampling is described below.

3.9.1 Quarterly Groundwater Sample Collection

Groundwater samples have been collected quarterly since installation. Groundwater samples are collected quarterly from all 18 groundwater wells outside of the CAMU at the USS Lead site and analyzed to assist in characterizing the groundwater associated with determining the nature and extent of contamination and as part of the ecological evaluation of the site. Groundwater graphs were produced for all quarterly groundwater data for antimony, arsenic, cadmium and lead. Groundwater graphs are illustrated next to the applicable monitoring wells in Figure 21.

Groundwater samples are collected from on-site monitoring wells in general accordance with the *Groundwater Sampling and Analysis Plan*, date May 11, 2000, prepared by Adrian Brown for USS Lead Refinery, Inc. The *Groundwater Sampling and Analysis Plan* was developed as part of the Interim Stabilization Measures requirements. Groundwater samples are collected from eighteen monitoring wells: four monitoring wells, MW-01, MW-03, MW-04, and MW-05, were installed by ENTACT, Inc., on August 19, 1996; monitoring wells MW-06 through MW-14 were installed by LAW; and MW-15 through MW-25 were installed by LAW (February 2001). One existing monitoring well MW-2 was destroyed by heavy equipment and has been abandoned.

Prior to the collection of the groundwater samples, the wells are purged and a minimum of three well volumes of water are removed from each well to ensure that the samples collected are representative of the zone being monitored. Purging and groundwater sample collection is conducted utilizing a dedicated disposable bailer. Field measurements of pH, conductivity and temperature readings are collected during well purging activities prior to sample collection. Water purged from the wells is transported to and disposed of in the CAMU.

Groundwater samples are collected in general accordance with the *Groundwater Sampling and Analysis Plan*, dated May 11, 2000. Groundwater samples are analyzed to assess the level of constituents of concern previously identified in the report entitled *Hydrogeology and Groundwater Sample Results*, dated

December 19, 1996 and based on information obtained during the implementation of the ISM. The objective of the groundwater sampling is to determine if the facility has impacted the uppermost aquifer. Analytical results are compared to remediation cleanup objectives, provided by the Indiana Department of Environmental Management, Risk Integrated System of Closure (RISC) Technical Manual.

The groundwater samples are collected immediately following purging or after the well recharged a sufficient volume of water for sampling if the well is bailed dry. Groundwater samples collected by LAW were sent to Test America, Inc. in Bartlett, Illinois, an approved EPA laboratory. Groundwater samples are now analyzed by Severn Trent Laboratory, an approved EPA laboratory for the following analysis:

- Appendix IX VOCs utilizing EPA method 8260B (one quarter per year)
- Appendix IX SVOCs utilizing EPA method 8270C (one quarter per year)
- Dissolved mercury, arsenic, selenium, lead, thallium, cadmium, and antimony utilizing EPA methods 6010B, 204.2, 7470A, and 7841.
- Modified Appendix IX dissolved metals (except mercury, arsenic, selenium, lead, thallium, cadmium, and antimony), utilizing EPA method 6010B
- Cyanide utilizing EPA method BT03-26.1 (one quarter per year); and
- Sulfide utilizing EPA method 376.1 (one quarter per year).

Field analyses for all samples includes: pH, conductivity and temperature. Field parameters are important as part of characterizing general water quality.

3.9.2 *Revised MRFI Work Plan Addendum Groundwater Sampling*

There are currently twenty four (24) groundwater monitoring wells on-site which are monitored quarterly according to the Interim Status Groundwater Monitoring Plan (ISGWMP), dated October 16, 2000 and approved by IDEM. Eighteen (18) groundwater monitoring wells on the USS Lead site are located outside of the CAMU. Currently, groundwater samples are collected from outside the CAMU and analyzed for antimony, arsenic, cadmium, lead, mercury, selenium and thallium quarterly and Appendix IX metals, Appendix IX VOCs and SVOCs annually. Groundwater slug tests were conducted by ENTACT, Inc. (*Report of Site Hydrogeology and Groundwater Sample Results*, December 19, 1996, Section 3.4, Page 17-18) at the USS Lead site and the geometric mean of the site-specific hydraulic conductivity was calculated to be 60 ft/day.

Groundwater analytical data collected under IDEM illustrate that method detection Limits (MDLs) for some metals, specifically, mercury, silver and thallium have not been below Michigan State Groundwater-Surface Water Interface Criteria (MI GW-SWIC), and hardness has not been analyzed. Hardness is used to calculate the action limit for approximately seven metals.

To thoroughly characterize the USS Lead site nature and extent of groundwater, a groundwater study was proposed as part of the *Revised MRFI Work Plan Addendum* and groundwater samples were collected and analyzed with lower detection limits to be compared with MI GW-SWIC. For the *Revised MRFI Work Plan Addendum* groundwater sampling, the following changes to current USS Lead site quarterly groundwater monitoring were performed:

- Silver and thallium were analyzed by analytical methods with lower detection limits;
- All groundwater wells outside of the CAMU were analyzed for hardness;

- Groundwater samples were collected unfiltered and collected using low-flow techniques, in accordance with *U.S. EPA RCRA Ground-water Monitoring: Draft Technical Guidance*, dated November 1992 (Section 7.0); and
- Pumping tests were performed on 3 wells (MW-05, MW-13 and MW-23) in accordance with *U.S. EPA RCRA Ground-water Monitoring: Draft Technical Guidance*, dated November 1992 (Section 4.3.4.1, pages 4-48 through 4-50).

Groundwater samples were collected for the *Revised MRFI Work Plan Addendum* according to the procedures provided in and in accordance with the *U.S. EPA RCRA Ground-water Monitoring: Draft Technical Guidance*, November 1992. Groundwater samples collected for the *Revised MRFI Work Plan Addendum* were collected using low-flow techniques. Groundwater samples were sent to the approved laboratory, STL, for analysis. Groundwater samples were analyzed as follows:

- Field parameters of pH, specific conductance, and temperature were collected at all groundwater wells.
- Groundwater samples were collected unfiltered and run for total metal analyses. All groundwater samples were analyzed for hardness. All Appendix IX metals except mercury, lead, silver and thallium were analyzed using EPA Method 6010 to meet MI GW-SWIC. Lead, silver and thallium were analyzed by EPA Method 6020, to lower the MDLs and mercury was analyzed by EPA Method 1631 as proposed in the *Revised MRFI Work Plan Addendum*.

3.9.3 QA/QC Samples

Sample duplicates, field rinsate blanks and trip blanks are collected quarterly and analyzed as follow:

- A sample duplicate is collected for a minimum of 10% of the samples which for the samples. Duplicate samples are analyzed for the same suite as that proposed on the original sample.
- One field rinsate blank is collected per day of sampling. Field rinsate blanks are analyzed for a completed suite of analytes.
- One trip blank is included per cooler of samples to be analyzed for VOCs and SVOCs (one quarter per year).

3.10 Canal Access Road, Fuel Tank Storage Area and Holding Ponds Sampling, Excavation and Confirmatory Sampling

The *ISM Work Plan* set forth a sampling strategy to characterize the extent and level of contamination in the sediment of the outfall canal leading to the Grand Calumet River. The canal was characterized and remediated according to the *ISM Work Plan*. Impacted material from the base of the canal was stabilized and placed in the CAMU. Additional excavations in the vicinity of the canal that have been completed include the canal road and the fuel tank area. During excavation of the canal, contaminated material was transported to the CAMU using the canal access road, and therefore some cross-contamination on the canal access road was excavated. The fuel tank storage area, located next to the canal, was identified and excavated by ENTACT as reported in the *Fourth Quarter 1997 Progress Report*. During site-wide sampling activities, additional sampling was performed and additional excavation on the fuel tank storage area was conducted concurrent with excavation of the canal access road. During sampling of the canal

access road, the holding ponds, used throughout material removal activities, were also sampled. These excavations were completed as part of the ISM for the USS Lead site.

The volume estimates for each area are as follows (based on survey data and information from USS Lead):

- Canal Access Road – 5,167 yds³
- Fuel Tank Area – 28,711 yds³

Total – 33,878

The excavated material was placed in the on site CAMU and the excavations were backfilled with clean sand mined from northern portion of the property. The confirmatory soil sample data is provided in Table 7 and illustrated in Figure 18.

3.11 Grand Calumet River Sediment Characterization

IDEM has completed the *Assessment of Sediment Injury in the Grand Calumet River, Indiana Harbor Canal, Indiana Harbor, and the Near Shore Areas of Lake Michigan*, prepared for the US Fish and Wildlife Service in October 2000. The Grand Calumet River appears to be contaminated with PCBs, VOCs, SVOCs and dioxins. During the *Revised MRFI Work Plan Addendum*, soil/sediment samples collected in borings next to the Grand Calumet River contained concentrations of PCBs, VOCs, SVOCs and dioxins not measured previously at the USS Lead site. Further, during remediation of the canal, concentrations of PCBs, SVOCs and TPH increased toward the Grand Calumet River.

3.12 Lead Area of Influence Study

Northwest Indiana has been and remains a highly industrialized area. For over a hundred years Northwest Indiana has been a hub for heavy industry, including major steel mills, foundries, lead smelters, waste incinerators, refineries, petrochemical bulk storage facilities, landfills, power generation plants, chemical-processing plants, and chemical bulk storage facilities. The influence of so many potential contaminant sources has complicated the surface soil lead concentrations in this area to the point that lead is ubiquitous and highly heterogeneous in surface soils at concentrations above conventional background concentrations.

As part of the MRFI, LAW and others completed a historical review for the purpose of cataloging known and suspected lead sources in the vicinity of the subject property. Information was gathered from regulatory databases, USS Lead historic documents, Indiana's State Inventory Program (SIP), and regulatory files for specific facilities. Sources of lead in the vicinity of the subject property, included E.I. Dupont, Eagle Pitcher, Anaconda, Hammond Lead, Blaw Knox Foundry, BP Amoco Oil Company Refinery, Cerestar USA, Inc., East Chicago Municipal Incinerator, Indiana Harbor Coke Company, Ispat Inland Steel Inc., LTV Steel, Marblehead Lime Company, and NIPSCO-Mitchell. Also, prior to lead removal from gasoline, lead from automobile emissions was a significant contributor to lead in the environment, particularly in the Greater Chicago area where heavy automobile traffic has existed for nearly a century.

In the *Indiana's 1999 State of the Environment Report*, statewide lead emissions steadily decreased during the 1980's, but have actually been on the rise since 1993. From 1993 to 1996 statewide emissions of lead increased from approximately 49 tons per year in 1993 to 58 tons per year in 1996.

In the *Great Lakes Regional Air Toxic Emissions Inventory Report* (March 1999), lead was one of 49 parameters inventoried from point and area sources. Lead emissions from the Great Lakes Region was estimated at 996,615.04 lbs. in 1993. Lead emissions from Lake County, Indiana in 1993 were estimated at 134,476.65 lbs., which accounts for 13.5% of total lead emissions from the Great Lake Region. The emission data compiled in the study by LAW was compiled from annual emissions reports required under the emissions statement rule. It is important to note that USS Lead closed its facility in East Chicago in 1985, but point and area sources from major industrial sources in Lake County continue to emit significant amounts of lead into the environment.

Indiana initially cataloged lead emissions data in Northwest Indiana as part of the Statewide Inventory Program (SIP) completed in the mid-1980's. Consequently, lead emissions data for industries not in operation at that time are unavailable through public sources. Eagle Pitcher and Anaconda are former lead smelters that were not in operation when the SIP data was compiled, but likely represent significant sources for historic lead emissions. Also, lead was apparently not part of E.I. DuPont's process in the mid-1980's, however, review of publicly available information on file with IDEM indicates that E.I. DuPont produced lead arsenate (insecticide) and other lead compounds from 1910 up to 1949. E.I. DuPont, Eagle Pitcher, and Anaconda are (were) located within 0.25 miles to the north and east of the subject property. Known lead emissions (SIP data) from Hammond Lead were modeled along with USS Lead lead emissions as part of the historic air emissions investigation which is included in Appendix 1.

3.13 Historical Lead Air Emissions

As part of the MRFI, LAW conducted an independent assessment of impacts of historical process air emissions of lead in the East Chicago, Indiana area, in the vicinity of the USS Lead site. The *Draft Independent Assessment of the Impacts of Historical Lead Air Emissions in East Chicago, Indiana*, submitted by LAW to the US EPA on November 14, 2000 is included in Appendix 1.

The historic air emissions study illustrates that USS Lead's air emissions were not the sole source of lead in the area, and that there are multiple contributors to the elevated soil lead concentrations. Other possible sources of lead in the vicinity of the USS Lead site are illustrated in Figure 22. Examples of the other possible sources of lead in the USS Lead vicinity are the Anaconda Lead Products and the International Lead Refinery Company, both located to the northeast of the site. LAW assessed the historic sources of lead in the vicinity of the USS Lead Site.

In response to LAW's assessment and air modeling, TechLaw submitted the draft report *Air Dispersion Modeling and Historic Aerial Photography Review* to US EPA on April 5, 2002. The TechLaw report compared TechLaw results to the *Draft Independent Assessment of the Impacts of Historical Lead Air Emissions Report* prepared by LAW. The *Air Dispersion Modeling and Historic Aerial Photography Review* prepared by TechLaw is provided in Appendix 2. A *Draft Addendum to Air Dispersion Modeling and Historic Aerial Photography Review* is also included in Appendix 2. Both assessments were summarized in Section 2.5.1 above.

3.14 MRFI Work Plan Addendum – Off Site Sampling

The *MRFI Report Addendum - Off-Site Sampling and Analysis Report* ("Off-Site Report") was submitted by Geochemical Solutions on October 15, 2001 on behalf of USS Lead to US EPA and IDEM in response to comments from US EPA in a letter dated March 14, 2001 and to better determine the nature and extent of windborne contamination from the USS Lead facility. The *Off-Site Report* was submitted following review of the *Draft MRFI Report*, submitted to US EPA by LAW on December 29, 2000 to describe the sampling activities and to report all the soil data collected during the off-site investigation. Data was collected according to the *MRFI Work Plan Addendum*, dated April 10, 2001 and approved by US EPA on May 30, 2001.

DAI Environmental and USS Lead collected initial laboratory samples on May 3, 2001. These samples were sent to the US EPA approved ACZ Laboratories, Inc (ACZ), in Steamboat Springs, Colorado to be used as field calibration samples for the field X-Ray Florescence spectrophotometer (XRF). Once laboratory results were received, additional field activities were conducted on June 5-8, 2001 by Geochemical Solutions and DAI Environmental with oversight by US EPA's contractor TechLaw. Sampling and analysis procedures were conducted according to the approved *MRFI Work Plan Addendum*, dated April 10, 2001. As a result of sample concentrations, excavation was proposed for off-site areas which may be influenced by soil lead migration from the USS Lead site. Pre-Excavation XRF screening was performed off site for a total of forty-seven surface soil samples and twenty-two depth profile samples. Sixteen additional cluster samples were collected to determine if stop criteria had been met. Seventeen samples were collected for laboratory analysis, choosing samples of interest such as a sample below residential standards or an increasing trend from another source. The Pre-Excavation Off-Site Report Data are provided in Table 8, Table 9, Table 10, Table 11 and Table 12. After excavation was deemed necessary, additional pre-excavation samples were collected as illustrated in Figure 10 by "OSS" and the data are provided in Table 13.

Material was removed from the triangle area, from Howard Industries property and from the Indiana Harbor Belt Railroad property as described in Appendix 3, Appendix 4 and Appendix 5, respectively.

3.14.1 Analytical Results

The comparison of fine and total soil sample results collected during the *MRFI Addendum – Off-Site Sampling and Analysis* is reported in Table 8 and can be summarized as follows:

- An average of 74.1 % of the soil is in the fine fraction, passing a 60 mesh sieve.
- Lead soil concentrations did not vary significantly between the fine fraction and the total soil sample. On average, the relative percent difference between the lead concentration in the fine fraction and the total soil sample was 8.1%.

Laboratory and field XRF soil samples results are compared in Table 11 and the comparison can be summarized as follows:

- The laboratory and field XRF data showed very good reproducibility. The average RPD between the laboratory and field sample was 0.93 % and the RPD for 88.2% of the samples were within 35%, the EPA standard RPD for soil duplicates.
- Two sample pairs had RPD greater than 35%. In one sample pair, the laboratory analysis had a higher concentration than the field XRF concentration, and in the other sample the laboratory

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analysis reported a lower concentration than the field XRF concentration. This suggests that heterogeneity in the sample results is a result of heterogeneity in the soil.

The laboratory and field XRF comparison illustrates that the field and laboratory data were in good agreement and that heterogeneity in the sample results were a result of heterogeneity in the soil.

Surface soil samples results are provided in Table 8 and Table 9. The results can be summarized as follows:

- Surface soil lead concentrations decrease rapidly with increasing distance from the site with the exception of areas where significant fill was encountered. Soil lead concentrations were below Region 9 PRGs for residential soil within approximately 146 feet to the north on T-1, 493 feet to the north on T-2, 970 feet to the northeast on T-5 and 304 feet to the northeast on T-3.
- Soil concentrations to the north of the site decreased to 605 mg/kg and then increased along the road north of the site.
- Soil concentrations along the eastern boundary of the site varied significantly. The highest lead concentrations were located closest to Area A, the former remediation unit with the highest concentrations of lead on the site, and extended approximately 262 feet to the east. Area A has been remediated and contained within the CAMU.
- It is evident that material containing lead was used as fill material in all offsite areas. It is likely that all of the fill material was in place during historic operations at the USS Lead site, and the historic emissions from the site would be in addition to the lead in the fill material. The presence of fill material was clearly evident during sampling of Transect 5 in several places. First, railroad ties and debris are visually present in the triangle area. Second, it was evident that the swales in the dune and swale topography had been filled with slag-like material containing lead. Soil concentrations on the dunes were well below Region 9 PRGs for residential soil (average 71 mg/kg) and in the swale, concentrations were above Region 9 PRGs for residential soil (average 799 mg/kg). Two such locations, T5-6 and T5-5, respectively, were located only 42 feet apart.
- The low concentrations of lead (below Region 9 PRGs for residential soil) on the dunes and measured in samples north and northeast of the USS Lead site suggest that emissions from the smelter stack at the USS Lead site were not significant, and in the dominant wind direction, extended no more than 970 feet.
- There were no trends from the USS site along Transect 4 except that lead concentrations are higher along Kennedy Avenue east of the site than other samples and sample trends away from the site (i.e. Transect 1 and 2). High lead concentrations due east of the slag pile storage area (Area A) were observed and can be attributed to the USS Lead site, however the average concentration of samples along Transect 4 was 2,850 mg/kg (excluding samples T4-9 and T4-10) which suggests that the fill material used during construction of the road/railroad/cable/pipeline and the influence from automobile exhaust on Kennedy Avenue increased lead concentrations to 1000-3000 mg/kg. This is further substantiated by the depth profiles at T4-6 and T4-10 which contained concentrations greater than 1000 mg/kg at depth before reaching refusal at 18 and 12 inches bgs, respectively.

Six depth profiles were performed. Depth profile soil samples results are provided in Table 10 and the results can be summarized as follows:

- Four of the six soil profiles had soil concentrations decrease with increasing depth. Sample lead concentrations in three of the four profiles were below Region 9 PRGs for residential soil (400 mg/kg) at 6 to 12" bgs.
- At sample location T4-10, the soil concentration increase and then the soil auger encountered refusal at 12" bgs. This suggests that fill material was used and the extent of contamination from the USS Lead Site could not be determined.
- Refusal was also reached at depth profile location T4-6 at 18" bgs.
- At sample location T3-3, all three samples taken during the depth profile were below Region 9 PRGs for residential soil (400 mg/kg).

3.14.2^{*} Conclusions

The off-site sampling results delineated the nature and extent of off-site contamination from the USS Lead site. The following conclusions can be made from the results of the off-site sampling and analysis conducted in accordance with the approved *MRFI Work Plan Addendum*:

- Surface soil lead concentrations decrease rapidly with increasing distance from the site. USS Lead potential influence on soil lead concentrations were within 320 feet to the north (average distance from Transect 1 and Transect 2), within 637 feet to the north-northeast (Transect 3 and Transect 5) and within approximately 262 feet to the east (Perpendicular 2). One potential area of influence from the USS Lead site to the northeast covered the triangle area.
- Soil concentrations in Transect 2 decreased to 605 mg/kg and then increased along the road north of the site.
- Soil concentrations along the eastern boundary of the site varied significantly, however were higher than lead concentrations measured on other transects. The highest lead concentrations were located closest to Area A, the former remediation unit with the highest concentrations of lead on the site. Area A has been remediated and contained within the CAMU. High soil lead concentrations east of the site are influenced by material used as fill, topographic highs and low such as Kennedy Avenue, and automobile exhaust.
- It is evident that material containing lead was used as fill material in the area around the site. This was evident during sampling of Transect 5 and during depth profiles in Transect 4. Fill encountered during material removal is illustrated in Figure 16.
- USS Lead has potential influence on the triangle area and for the area to the east of the former slag pile, however, within those areas, there are other sources of lead containing material and activities other than USS Lead. This was evident during material removal activities.

Soils were excavated in the triangle area, Howard Industries and along the west side of Kennedy Avenue as a result of the off-site sampling and analysis activities. After material was excavated, confirmatory soil samples were collected. Confirmatory soil sample results are provided in Table 14 and Table 15 and sample locations are illustrated in Figure 18 (where backfilled) and Figure 20.

3.15 Wetlands Area Investigation and Excavation

Elevated lead concentrations in the wetlands were initially discovered during site-wide sampling activities conducted by Law Engineering in 1999. Two random sampling locations (SS-01-01 and SS-01-04) were

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located in the eastern portion and western portion of the wetlands, respectively. Both samples were found to contain elevated lead concentrations. Subsequent samples collected around these locations indicated the elevated lead concentrations were concentrated in the upper portion of the soil and root mass of the wetlands. As in other areas of the site, lead concentrations were observed to decrease dramatically below twelve (12) inches. USS Lead also attempted to define the lateral extent of the lead impact. In general, lead concentrations were observed to decrease away from Area A. The subsequent sampling events identified an area of more than two (2) acres where lead concentrations existed in excess of 10,000 milligrams per kilograms (mg/kg). The area of greatest impact abutted Area A and extended several hundred feet to the west and southwest. Due to the high concentrations of lead observed in this area it was considered a secondary source area. USS Lead decided to excavate this secondary source area and place the excavated material in the CAMU. The purpose of the wetlands excavation was to remove the highest area of impact. Remaining soil concentrations above RISC Tier 1 Industrial Closure Levels are present in the wetlands area on the southern portion of the site. The metals in that area are not mobile as indicated by Site-Wide groundwater results, *Revised MRFI Work Plan Addendum* surface water results and excavation in this area is not possible. A full scale excavation of the entire wetland area exhibiting lead concentrations in excess of 1,300 mg/kg was deemed impractical because complete excavation would have resulted in a near complete devastation of the wetland environment on the site. Further, the bioavailability testing reported in Section 2.6 above suggested that less than 50% of the total lead concentration is bioavailable. The sampling and excavation activities completed in the wetlands (Area 3) in August and September of 2002 are described in detail in Appendix 6. Pre-excavation wetlands data are illustrated in Figure 11 and confirmatory wetlands data are illustrated in Figure 18 (under backfill) and Figure 20.

3.16 Revised MRFI Work Plan Addendum

In July 2003, twenty-four (24) sample locations were sampled for a total of 36 soil/sediment, fill and surface water samples were collected and 18 groundwater samples were collected, one from each well outside the CAMU to further test that cross-contamination of fill did not occur during ISM activities, to fulfill data gaps in defining the nature and extent of contamination at the USS Lead site, and to insure that the site is protective of human health and the environment.

On-site field investigations were conducted to ensure that adequate coverage of the USS Lead site was completed. This field investigation was conducted after all removal activities had been completed and the CAMU was filled and capped.

All samples were sent to Severn Trent Laboratories (STL), University Park, Illinois, a US EPA approved laboratory. STL performed prior soil/sediment, surface water and groundwater analyses for USS Lead site.

Soil/sediment analysis was conducted to characterize the nature and extent of contamination, to evaluate ecological exposure and to verify that the site is protective of human health and the environment. Samples were analyzed for Metals, Appendix IX VOCs and Appendix IX SVOCs, PCBs, dioxins and physical parameters of paste pH by EPA Method 9045, Total organic carbon by a modified EPA Method 9060, Cation Exchange capacity (CEC) by EPA Method 9081, and moisture content will be analyzed by ASTM method D-2216.

Five (5) surface water samples were collected and analyzed at the USS Lead site to assist in characterizing the surface water at the USS Lead site associated with determining the nature and extent of contamination and as part of the ecological evaluation of the site. Field analyses for all samples will include: pH,

conductivity and temperature. Surface water samples were collected and sent to the approved laboratory for analysis. Surface water samples were collected unfiltered and run for total metal analyses and analyzed for mercury by EPA Method 1631. Three surface water samples were analyzed for a limited suite of metals (Sb, As, Cd, Pb and Zn) and for hardness. The limited suite contains the primary constituents of concern at the USS Lead. Two surface water sampling locations (location 2 – Area B, and location 6 – Area 3) were analyzed for Appendix IX metals to thoroughly evaluate ecological receptors at the USS Lead site. Only antimony, arsenic and barium were detected in previous surface water sampling at the USS Lead site. All Appendix IX metals except mercury, lead, silver and thallium were analyzed using EPA Method 6010 to meet EDQLs. Lead, silver and thallium were analyzed by EPA Method 6020, to lower the MDLs and mercury will be run by EPA Method 1631 as proposed in the *Revised MRFI Work Plan Addendum*. All surface water samples were analyzed for hardness using EPA Method 130.1. Surface water hardness is used in calculating regulatory surface water criteria and is an important parameter in evaluating ecological exposure to metals.

The sampling equipment, sampling locations, sampling procedure, quality assurance project plan (QAPP), project management plan and schedule for the proposed sampling were described in the *Revised MRFI Work Plan Addendum*.

As part of the *Revised MRFI Work Plan Addendum*, groundwater samples were collected using low-flow sampling. In addition, three groundwater pump tests were performed in monitoring wells MW-05, MW-13 and MW-23. Groundwater samples were analyzed using the same analytical methods as described for the surface water samples. The groundwater analytical data are provided in Table 22. The pump test data are provided in Attachment 2.

4.0 CONCLUSIONS

USS Lead site work has been conducted according to the approved MRFI, prepared by ENTACT, Inc and dated September 18, 1997 and in partial fulfillment of the US EPA AOC, Docket number V-W-001-94.

The MRFI site characterization began when lead contaminated soils were found present at the USS Lead site, and continued concurrent with remediation activities. The on-site sampling and analysis delineated ISM areas Area A, Area B, Area C and the canal. During site-wide sampling and analysis, additional removal areas were identified. Most soils that were identified as contaminated were removed and consolidated in the onsite CAMU. Continued sampling in the wetlands, identified elevated contaminated levels that cannot be removed from the wetlands due to physical constraints and therefore remain in place. Bioavailability testing of wetlands soil/sediment shows that less than 50% of the total lead and arsenic concentrations in the soil/sediment are bioavailable to organisms. Further, surface water and groundwater analyses show that the lead is not mobile to the groundwater or surface water. Arsenic concentrations exceed IDEM Tier 1 levels in groundwater near the former waste storage areas, but decrease rapidly with increasing distance. Arsenic remains below IDEM Tier 1 levels in all monitoring wells at the downgradient perimeter of the site.

Off-site migration of lead contaminated soils from the USS Lead site occurred with close proximity to the USS Lead site and was first identified and sampled along the perimeter railroad. Off site air dispersion was modeled by LAW and TechLaw and then substantiated using soil samples as proposed in the *MRFI Work Plan Addendum* and as described in the *MRFI Addendum Off-Site Sampling and Analysis Report*. Sample results initiated off-site remediation as described in Appendix 3, Appendix 4 and Appendix 5. During off-site excavation debris and slag from unknown sources was encountered, and data suggested that contamination from the USS Lead site decreased with increasing distance from the USS Lead site. Further, lead slag used as fill off-site is evidenced by increasing lead concentrations with depth at several locations.

The depth of the many reports and investigations conducted for the USS Lead site suggests that the USS Lead site has been thoroughly investigated both prior to excavation, during excavation and post-excavation to confirm that removal of contaminated materials was comprehensive. The remaining nature and extent of contamination from activities conducted on the USS Lead site is limited to the wetlands area and is not available to humans. Moreover, the bioavailability is limited by the nature of the contaminants at the USS Lead site.

